The MINING CONGRESS JOURNAL

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The Consumer Family reads about **OLD COMPANY'S LEHIGH ANTHRACITE** *in the home newspaper*

THE EVENING BULLETIN—PHILADELPHIA

OLD COMPANY'S LEHIGH

THE BEST SINCE 1820

How Can You Be Sure of a Comfortable Contented Winter

THE greatest cold-weather annoyance is a heater that won't heat—or a heater that must constantly be coaxed and wheedled into doing its duty.

But, if you are fair to your heater, it will be fair to you—unless it is a very poor one indeed.

Being fair to your heater is, first, seeing that it and the flues leading from it are free from soot accumulations. For soot is an insulator between the fire and the heating surfaces.

Second, your heater must have good coal if you expect it to give a good account of itself. That is, the right kind and right size of coal for its particular type and capacity.

Old Company's Lehigh Anthracite and the Old Company's dealer are the combination to solve your heating problems and assure you of ample heat in your home at all times.

Old Company's Lehigh is a pure coal, with over a hundred years of proof behind it. Its purity and uniformity is the best possible guarantee of safe, steady heat—equal to any condition.

This assurance is made doubly sure by the aid of the Old Company's dealer in delivering Old Company's Lehigh to you in proper condition, in assuring you the correct size of coal for your heater, and in giving you full information on the most approved methods of firing—for greater economy and simplified care.

OLD COMPANY'S LEHIGH ANTHRACITE

THE LEHIGH COAL AND NAVIGATION COMPANY

Tennis Player at a Disadvantage When Caught in 'Forbidden Zone'

Coming Home

A greatly reduced reproduction of one newspaper advertisement of the Fall Series on OLD COMPANY'S LEHIGH.

All to aid the Dealer's Sales

LAST MONTH saw the launching of the Old Company's Fall Campaign of advertising in the newspapers, on the radio, the mails, in the show-windows, and elsewhere.

And all of this big job is being done to aid Old Company's dealers to increase their sales on "The Best Since 1820".

As the consumer gets the story of Old Company's Lehigh from all directions, he is bound to be convinced of the quality of this fine old fuel and to get the famous "bull's-eye" impressed on his mind as the guiding sign in coal-buying.

When he buys, he must buy of his Old Company's dealer, and so the dealer must profit before the producer can profit.

THE LEHIGH COAL AND NAVIGATION COMPANY

1421 CHESTNUT STREET PHILADELPHIA, PA.

New York - Boston - Buffalo - Springfield, Mass.

The MINING CONGRESS JOURNAL

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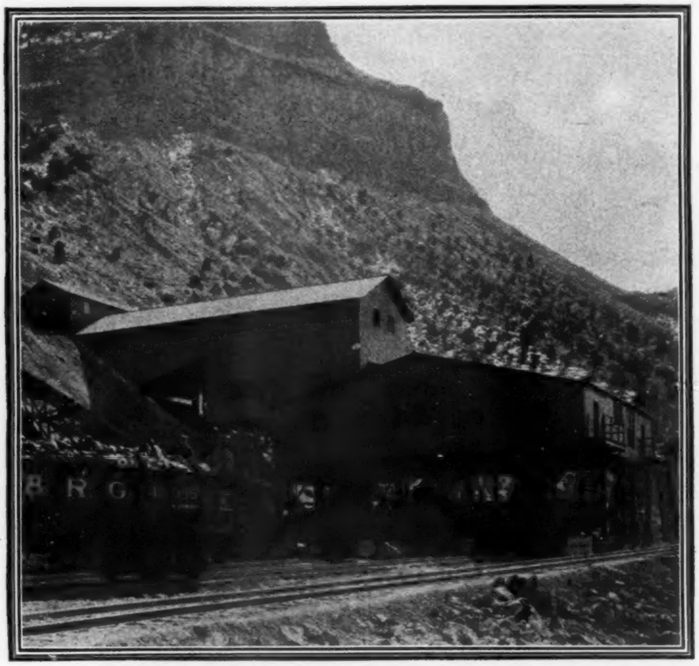

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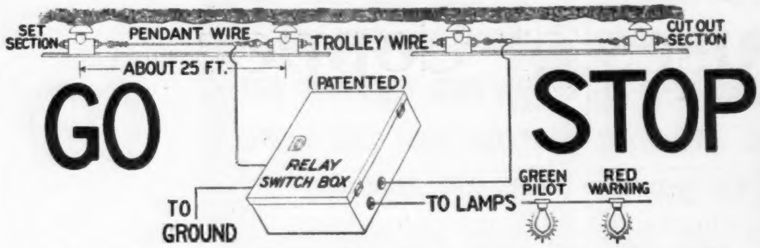
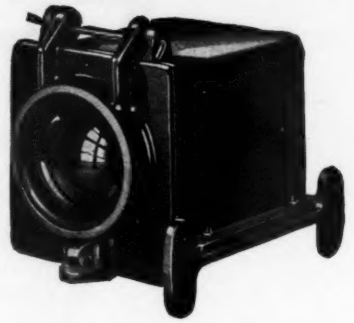
SPEED UP HAULAGE and INCREASE SAFETY





Canton Automatics make the non-stop trips possible by removing from the haulway every cause for delay

Speeding up the haulage system and at the same time reducing labor costs and accident hazards may obtain in any coal mine through use of Canton Automatic Devices.

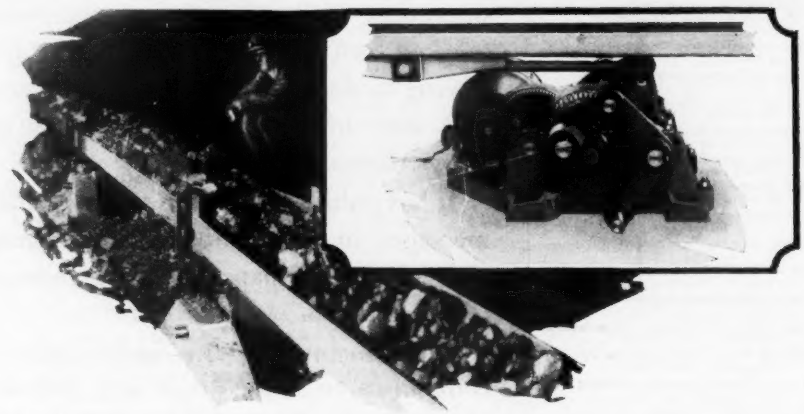
Canton Automatic Mine Doors, Automatic Flaggers and Automatic Switch Throwers eliminate the human element from the haulageway. Canton Automatic Mine Doors automatically open and close as trips pass through—Canton Flaggers show at a glance whether track ahead is clear—Canton Automatic Switch Throwers save hand-switching and add largely to the security of haulageways.

"When you think *haulage*—think *Canton Automatics*"

AMERICAN MINE DOOR COMPANY
2063 Dueber Ave. ~ Canton, Ohio

AUTOMATIC LABOR SAVING SAFETY EQUIPMENT

Your COAL moves forward smoothly, continuously, *quietly*



With the Vulcan Shaking Chute on the job, your coal moves forward at a uniform speed. The forward stroke of the drive kicks the coal forward. Momentum makes the forward motion continuous. Almost noiseless except for the swishing of the coal as it slides in a steady stream toward the car.

The operation is simplicity itself. No wearing parts to get out of order. Chute sections, mounted on rollers, are moved by reciprocating action.

Less than 9-inch clearance required. Low in first and ultimate costs.

Write for your copy of the Vulcan Shaker Chute Bulletin.

VULCAN IRON WORKS—Wilkes-Barre, Pa.

VULCAN of WILKES-BARRE
SHAKING CHUTES


THIS CYLINDER CONTAINS
PREST-O-LITE
ACETYLENE
CLOSE VALVE WHEN EMPTY

The

MINING CONGRESS JOURNAL

**A Monthly Magazine—The Spokesman For The Mining Industry—
Published By The American Mining Congress**

VOLUME 14 | October, 1928 | No. 10

Editorials

Labor-Day Talk

THE Machine bogey was the theme of the Labor Day address of President Green of the American Federation of Labor. That he was slightly confused about the value of machine production is evidenced by his remarks. He said:

"One of the chief objectives of labor is the establishment of the five-day week in all lines of industry. This great economic reform is made possible through the installation of improved machinery. * * *" and followed that statement with:

"If we must choose between scrapping machines and science, and human beings, we must scrap the machine. What will happen when we reach the saturation point? Will we eventually reach an entirely mechanical age? An age when only machines will be in demand and men will not be wanted?"

High standards of production have enabled industry to pay high wages. Unquestionably labor is better off today than ever before in its history. Admittedly that betterment has been accomplished through mass, or machine production. What, then, must we think of President Green's statements, particularly when with one hand he raises high the benefits to labor through the application of mechanical methods of production; and with the other hand raises the spectre of unemployment through the adoption of such methods? Where between these two extreme statements lies the truth?

Mechanization will not bring the millenium for the worker. Neither will it render him jobless. The results obtained during the last decade through mechanical production have been tangible—they are measurable. Certainly no greater evidence of its value is needed than a comparison of the wages and conditions of the working man in the United States during the last decade when machine production has been steadily increasing, and the condition of the working man of Europe, where the old methods of hand labor still obtain.

Students of the situation express no fear that the bugaboo of eventual unemployment, through machine replacement, erected by the Federation, will ever be a fact.

Mechanization is an emancipation of the worker, not a skeleton in the closet with which to frighten him.

Great Growth Is Slow Growth

NOTHING permanent or lasting is of the mushroom variety of growth. All great growth is slow. It is well for those who have criticized the slow process of the bituminous industry in its adoption of mechanical methods of production to remember this.

Superficially, the growth of mechanization in the mining industry has not been as rapid as it has in other lines of industry. Actually, considering all of the conditions it has had to surmount, it is indeed surprising in the results it has obtained. Not experimental results, but real results, lasting results; results that are changing the whole tenor of the bituminous coal industry.

The transforming of a coal property from the hand-labor type to the mechanized type is expensive. Only a few companies have had the resources which would enable them to make the experiment. But the step has been made, and the industry is rapidly accepting the facilities offered by increased mechanization. Approximately two hundred mines are now mechanized, and an equal number are seriously studying the possibilities in connection with their own operations.

Mechanization is slow growth—great growth—and it is taking firm root in the bituminous industry. It is beginning to send straight, strong shoots into the fertile soil, and every indication points to a strong, self-reliant tree, which will bring great benefit to the coal producer and to our industrial life.

Mechanization and Safety

THE increased use of mechanization is raising the question as to whether mechanized mining is safer than the older hand methods. It has been pointed out that in group working a number of men instead of one man are exposed to possible injury. It has further been pointed out that concentrated workings, increased use of power, roof action on longfaces, all may constitute new hazards that are not present in hand mining, or at least not present in the same degree.

These sources of danger undoubtedly do exist but to take the view that they make mechanized mining more hazardous than hand mining is to look through the wrong end of the telescope. The safety of any occupation is not measured by its potential dangers but by the effectiveness of the means which may be adopted to prevent accidents from occurring. The real comparison, therefore, between the safety of hand and mechanized mining is a comparison of the degrees to which safe mining practices can be enforced in the two methods.

In hand mining, it is well known that any safety rules adopted by a coal company are effective only so far as the men may choose to follow the practices recommended. In the scattered workings of a hand operation there is no way that the company can force a man to protect himself.

In mechanized mining this situation is changed. The men work in groups where they are subject to constant supervision so that effective safety practices devised to

eliminate the hazards brought about by new types of equipment and new methods of mining can be, and are being, enforced for the betterment of the working conditions and for greater safety to the men employed. Mechanized mining, therefore, offers to the coal industry, something which it has heretofore lacked—the opportunity to devise safety rules, to formulate safe practices, to design and install safety equipment, with the assurance that the efforts along these lines will not be wasted.

The New Union

AT PITTSBURGH recently a group of men avowedly opposed to the United Mine Workers of America met for the purpose of creating a new coal miners' union. They did create the organization and christened it The National Miners' Union. Its purpose is to supplant the present organization and to bring to it those who have been opposed to the admittedly bad tactics of John L. Lewis. There was the usual violence in the attempt to create the organization that has come to be a mark of trade-unionism in the mining industry. The police were called in, and the new union was born with the strife and warfare which has become symbolic of the movement.

Few will view the creation of the new union as significant. The interesting point is that it could be organized despite the resistance of the leaders in the old organization. Their constitution is designed to eliminate the weaknesses of the present organization, setting up a federation of autonomous local unions. It has declared itself "democratic in procedure"—a direct inference being that the autocracy of the U. M. of A. can not hope to survive.

But, what is more important, is the fact that there is no disposition on the part of the operators recently gone open shop to deal with any union, no matter how democratic. And from many sources comes the information, properly substantiated, that the men themselves have had enough of the union idea as espoused by the labor leaders in the bituminous industry. On the whole the outlook for the new or for the old union is not hopeful.

Is This A Perverted Viewpoint?

EDITORIAL comment on our attitude concerning Federal investigations of industry shows how widely viewpoints differ with respect to the value of the investigations of the last ten years. The *Baltimore Sun* questions the soundness of our criticism of these investigations, and refers specifically to the power investigation, mentioned by us, among others, as an example of the methods employed to discredit private enterprise.

We contend that nothing constructive has materialized out of any investigation of industry during the last ten years; that the taxpayers' money has been spent in useless probes; and that these investigations have proved futile as a basis for constructive legislation.

We are opposed to bureaucratic and political hypocrisy wherever it appears, and we believe it has been in evidence to an unconscionable degree in all recent congressional investigations, except the Senate gold and silver inquiry. We believe we are fully justified in this position by reason of the fact that voluminous misinformation and propaganda has been, and is being constantly circulated by public ownership advocates and organizations on the question of public versus private ownership of natural resources, the source of which ofttimes is cleverly concealed; and investigations have seemed to encourage un-American ideas and tendencies along this line.

We deplore the fact that Federal investigations, which should have been helpful in the solution of acute industrial problems, seem to have been prostituted by propagandists against private industry, particularly the natural resource industries, until they seem to have become merely agencies for the manufacture of scandal and political feuds instead of agencies for the solution of problems affecting the welfare of both industry and the public.

We are not opposed to intelligent governmental regulation of our great natural resource industries, where such regulation is clearly shown to be necessary. We are opposed, however, to any investigation that fails to bring to light the true situation involved. For example, if attacks upon the natural resource industries have made it necessary for them to engage in campaigns of education, an investigation should disclose all the facts concerning such attacks. If such attacks can be traced to any of the various brands of public ownership advocates—parlor bolshevists, socialists, popular government leagues, communists, and what-not—they should be exposed and accorded the same treatment as industry in making public the facts.

We do not question the desirability of Federal investigations conducted for the purpose of uncovering all the facts about an industry, problems as well as practices, causes as well as effects. When an investigation fails to serve this purpose, it is more conducive to harm than good. Surely this is not a perverted viewpoint.

Is Self-Protection Harmful?

THE electric power industry has spent millions of dollars in informing and instructing the public concerning the uses and benefits of electricity for lighting, cooking and power; concerning methods by which the consumer can avoid unnecessary expense, extravagance and waste; and concerning problems of the industry in which cooperation of the public is necessary to their successful solution. The lead, zinc, copper, oil and other industries likewise have conducted similar educational campaigns concerning their products. Due to these efforts on the part of industry, consumers have been enabled to save many millions of dollars and the fact that the use of these products has become so nearly universal in less than a generation clearly demonstrates the soundness of such a program.

We do not believe the circulation of such information through the medium of public schools, colleges, universities and libraries and through public meetings can be harmful to anyone except perhaps to those Government-ownership advocates and demagogues who see in such measures the defeat of their pet theories. Certainly no harm is done to the consumer or to the country in teaching the citizen and his children everything there is to know about an industry.

Equally, we believe that un-American principles may be so worked into the textbooks and literature used in the public schools that people, the Government and industry must constantly be on guard against the undermining influence of such concealed propaganda. It is not labeled; its source may be cleverly hidden, the identity of its authors may never be traced. An American industry should not be criticized for its legitimate ef-

forts to insure its own welfare and the welfare of the country in the manner heretofore described.

While public attention at the present time is focused upon the power industry, that industry is not alone in its effort to meet the insidious attacks upon private ownership and operation of natural resources.

Withdrawing Mineral Lands

EMPHATIC protest was made by the meeting of the Western Division of the American Mining Congress against the withdrawing of lands from entry by mineral location in order to preserve them for recreational purposes, until the proposed lands have been classified for mineral possibilities by a competent governmental agency. They also went on record in favor of restoration to mineral entry of any withdrawn lands that may subsequently be found to be mineral bearing.

No one objects to the desire of states to protect their scenic and beauty spots from needless destruction. But with a rapidly increasing population, increased consumption, and growing demands for all minerals, especially the metals, extraordinary care should be taken not to remove from the field of either the surface or geophysic prospector, any area that has not been thoroughly prospected and explored.

The discovery of one mine might be of sufficient commercial importance to outweigh all other considerations in the economic and industrial structure of the nation. National parks and playgrounds are splendid institutions if they do not operate to deprive the nation of potential mineral or industrial wealth and the people of employment that might otherwise become available.

Boundless Natural Resources

DR. GEORGE OTIS SMITH, Director of the Geological Survey, in an address before the joint meeting of the American Mining Congress and the American Institute of Mining and Metallurgical Engineers, declared vehemently in favor of "conservation of our natural resources," saying "optimism can not add a barrel or a ton to nature's store of indispensable mineral fuels and ores, upon which we are making larger and larger inroads each year."

As "a nation of boundless natural resources" he insists that we have been prodigal, even wasteful, and that we should wake up to the necessity of careful conservation. He did not add that usual bromide, "to provide for the generations yet to come."

There are two meanings to the word "conservation." One meaning is typified by Mr. Hoover, whose passion for the elimination of waste has become an obsession, and may well be adhered to by the Government and the entire industrial fabric of the country. The other is typified by Gifford Pinchot with his penny-pinching, resource-hoarding policy, which is inimical to the growth of the country.

Dr. Smith sounds a warning, tempered by common sense. All of us know that there has been waste in natural resources; that there is some waste today; that the natural inclination of any generation is to gather its harvest while it may, without great thought as to the next generation. Long ago, our high-grade copper ores would have been exhausted, and we might have been a copperless nation eventually had it not been for the genius of this generation in discovering methods for recovery of low-grade copper ores and the development of the greatest copper reserves on earth. With an unwise system of conservation, we should have hoarded our early high-grade ores, with the chances being wholly against the development of our present great industry.

It behooves the producer of minerals in this country to eliminate waste, to intelligently conserve our resources, not for the benefit of our great-grandchildren, but that the nation itself may attain the highest possible development with the resources at hand. The old adage of "Necessity being the mother of invention" is not obsolete. Let us preach elimination of waste, intelligent conservation and complete utilization.

Dr. Smith said, "The fact that our country has outplaced the world in producing mineral fuels and most of the raw minerals carries with it the obvious fact that our increasing speed is bringing us ever nearer the finish."

"Finish?" Where is there now a scientist or practical producing man who will admit that our supply of coal, copper, lead, zinc, iron or silver is approaching its end? Intelligent conservation, of course, but why raise the bogey of a mineral-less nation? Should we not rather encourage the search for new materials and continue the research and experimentation that every day is bringing nearer to economic utilization the vast deposits of low-grade raw materials that are already known?

Geophysic Prospecting

ADVANCE in geophysical sciences, particularly with respect to location of hidden ore bodies, promises to become of increasing importance, particularly in adjustment of the existing Federal mining laws. With this in mind, the meeting of the Western Division of the American Mining Congress, authorized that body to appoint a national committee "to investigate and compile, in so far as possible, facts covering the progress made in this science to date." The committee is to function immediately, and to submit to the Congress at the earliest time possible, a report recommending what changes, if any, they consider advisable in our Federal mining laws to give proper encouragement to the development of this promising science.

It is hoped that this organization will act promptly upon the suggestion of its Western Division, and that the results of the investigation may be made available as speedily as possible.

Reorganizing Government Departments

BOTH political parties are on record as favoring still further efforts to consolidate and rearrange government departments to simplify the contact channels for those having business in Washington. The present administration has done some work along this line, but much remains to be done to eliminate the multiplicity of bureaus, duplication of work, and to enable anyone to deal with the Government without undue loss of time and energy.

Mr. Hoover, an organizer of proven ability, has submitted a plan for such reorganization which seeks to establish boards or commissions to carry out semi-judicial or semi-legislative functions of government, and advocates measures to reduce waste and improve the service the Government should render its citizens.

His plan for the creation of boards or commissions, on the face of it, looks like creating greater confusion; his recommendation to divorce the judicial and legislative functions of the various departments from the purely

administrative has merit, providing he is able to climb over the demands of the job-holders and the job-seekers.

In the past it has been difficult for public officials to resist the pressure of political tradition, which has made of public offices places of reward for those who helped the party in power to victory at the polls. Possibly the time has arrived when tradition can be ignored, and every governmental department and agency can be made to function economically and efficiently.

The first step in Mr. Hoover's plan was the transfer of the Bureau of Mines and the Patent Office to the Department of Commerce. Whether the mining industry has been satisfied with that transwer is beside the point, but it is certain that the mining industry in any general reorganization of the departments would insist upon greater recognition of its importance in national affairs.

Running the United States Government on a purely business plane is a huge task, and so far has proved an impossible one. The plan advocated by Mr. Hoover perhaps has more merit than any yet advanced, and there seems to be a good chance of getting action under his direction, if he is returned to Washington in the presidential election.

The Law Orgy

According to T. R. Preston, president of the American Bankers' Association, "in the 140 years since the American Constitution was written, this Government has enacted more laws than all the rest of the civilized world combined since the birth of Christ."

A tremendous volume of criticism has been directed at our tendency to legislate both nationally and locally. And yet if we have been obsessed with the passion for law, who is responsible? We, the people of the United States, elect our state legislatures; we elect our Senators and our Congressmen. There is not one man among them that does not feel that he is reflecting the viewpoint of the majority of his constituents when he votes for or against legislative proposals. If we want the so-called law orgy stopped, there is no more effective manner in which to do it than through the ballot box.

But, as a matter of fact, we are "wanters." With steadily growing acumen we have urged legislation to take care of this or that situation until many of us literally believe that the enactment of a law will correct almost any evil or solve any problem.

Granting all Mr. Preston has to say, there are many factors to be taken into account in considering his statement. The number of laws necessary in the building up of what was at one time an "experimental republic" naturally were many; and a nation with such amazing and astounding growth in its 140 years of existence would require considerable law-passing to protect it and its citizens. Rather than marvel at the number of laws enacted, we are inclined to congratulate ourselves upon the very small percentage of unwise legislation that has found its way into the statutes.

Laws are necessary. They are the stabilizing force that has made us great. Laws framed with any degree of intelligence make for greater freedom for those who respect the rights of their fellow men. We are against hasty and unwise legislation, and we have opposed the tendency on the part of our legislatures to pass any old law, just so it was a law—just to create the illusion of doing something constructive.

Anyone who has attempted to get the cooperation of Congress in legislative matters will disagree with Mr. Preston as to the hasty action by that body. Congress is conservative, and there are many who will agree with the old pun that, "It takes Congress ten years to endorse the Lord's Prayer."

If the American Bankers' Association wishes to remedy the situation, as they view it, education of the masses to do things for themselves is the solution. But just so long as the people themselves demand laws, just so long will we have our annual supply.

The Electoral College

Speculation is rife concerning the effect upon the Presidential election of the failure of Congress since the 1920 Census to reapportion the membership of the House of Representatives in accordance with provisions of the Constitution, held by some to be mandatory. Inasmuch as the number of electors must be "equal to the whole number of Senators and Representatives to which a state may be entitled in the Congress," a reapportionment might have given certain states additional Representatives, and thus additional electors. Whether any state would have lost Representatives would have depended upon the plan of reapportionment adopted.

The fear has been expressed by certain writers that the November election may be contested. They see "possibilities of court, congressional, political, or even revolutionary action," and set up mathematical calculations to demonstrate that this fear is well founded. But we fail to see where there has been a violation of the Constitution such as would invalidate an election or furnish a basis for legal, political or congressional action of any kind. What could the courts do about it? The Supreme Court certainly could not hold the election invalid on the sole ground that Congress has failed to act on the matter of reapportionment. Congress certainly would not act to destroy the result of an election held strictly in accordance with means and machinery of its own making under a prior reapportionment. Political factions could do nothing without the aid of the courts or of Congress. And no state would have a valid basis for contesting the election since it is within the power of Congress to make a reapportionment that would leave the representation of such state exactly the same as it is at present, and it is not within the power of the courts to interfere.

It is inconceivable that anyone can seriously contemplate such contingencies, even though the elected candidate's majority in the electoral college should be but a few votes. However close the election results may be, there will be no contest because of this question of reapportionment.

Eternal Vigilance

A century and a quarter ago, the words "Eternal Vigilance is the Price of Liberty" stirred an audience of patriots. And then, as now, we may well suppose that there were those who smiled and said, "It is only a rabble; it will never amount to anything." Neither pacifist nor alarmists represent the alert and vigilant citizen; but to the sober-minded, thinking man-of-affairs we call attention to the communist campaign, previously referred to in our August editorial columns.

Led by Syndicalist Foster and Ex-Convict Gitlow, the Communist Party announces a campaign to "shatter the capitalist form of government," to "establish a Soviet Government in the United States," and to

"strike terror into the hearts of Republicans and Democrats alike."

That this boast may not be wholly ignored, is evidenced by the prompt action taken by the National Civic Federation and the American Federation of Labor to investigate the activities of this group and their subversive movements among college and university students. The movement has been started by a campaign fund of $100,000, to be carried on by fifteen national speakers and hundreds of regional orators. The women's division has established clubs, councils of housewives, and mothers' leagues.

Both Foster and Gitlow announce speaking dates in all the large cities of the country. As we stated in our editorial of August, the Communist Party polled over 36,000 votes in fifteen States in 1924. There are always certain weak-minded people who fall for blatant demagoguery; there is always a small number of disgruntled would-be politicians; and our immigration policy until recently admitted hordes of European malcontents. All of these furnish fuel for such movements, and it will be only by eternal vigilance that costly industrial unrest may be prevented. "Behold how great a matter a little fire kindleth."

Utah's Taxes Reduced

THE *Utah Taxpayer*, official organ of the Utah Taxpayers' Association, in its September issue shows how sixteen out of twenty-nine counties have paved the way for "good government at less cost." The majority of the states, counties, school districts and principal municipalities have lowered their tax levies for 1928-1929. The *Utah Taxpayer* refers to this as "the finest achievement in public financing since statehood."

Some years ago the Utah Taxpayers' Association was organized for the purpose of working with state and local officials in an effort to promote greater economy and efficiency in the administration of governmental affairs. Its membership embraced every class of taxpayers. Through its efforts proposed bond issues and public expenditures in every part of the State of Utah were subjected to rigid scrutiny, and as the result of the cooperation of taxpayers throughout the state, were restricted to absolute necessities, greater leeway being given to good roads and educational facilities than to any other kind of project.

The Utah Taxpayers' Association has proved the wisdom and efficacy of taxpayers' organizations in solving local tax problems. While the burdens of public debt and taxation have been increasing in other states and localities these burdens are on the wane in Utah. Through efficient organization taxpayers of Utah appear to have been able to secure the highest type of efficiency in the administration of their state and local governments.

The *Utah Taxpayer* sums up the situation with this comment: "Utah can point with satisfaction to this achievement which is looked upon as one of the finest and most substantial in public business since Utah became a state. Surely the persistent, intelligent and honest investigations which for several years have been going forward with the several units of this state by the taxpayers themselves are bearing wholesome fruit." The taxpayers of other states could well afford to follow the example and methods of Utah's taxpayers in undertaking to solve state and local problems of taxation.

The New Income Tax Regulations

OFFICIALS of the Treasury Department are at work on the regulations to be promulgated under the 1928 revenue law. Conferences have been held with taxpayers for the purpose of ascertaining their views concerning improvements in administrative methods that may be accomplished by amendments to the present regulations. Many helpful suggestions have been received by the Department and officials feel that the new regulations will be a vast improvement over the old.

However, there are a number of intricate problems that have to be solved. One of the most difficult sections of the law to deal with is that pertaining to consolidated returns of affiliated corporations. The Department feels that the new regulations should contain a better defined procedure regarding assessment and payment of the tax under a consolidated return.

The recent hearings before the Department on this subject showed a wide divergence of opinion between representatives of taxpayers as well as between these representatives and officials of the Department regarding the procedure that can be consistently followed. It appears that the requirements of the law in the case of affiliated corporations make necessary various legal steps in many instances to avoid double taxation of the same profit in the purchase and sale of assets of an affiliated corporation, depending upon whether the stock of such affiliated corporation has been dealt with rather than the assets. Procedure should be made so clear by the new regulations that the necessity for employment of astute counsel to deal with such situations should become the exception rather than the rule. Double taxation under the income tax law was not intended by Congress and should not be made possible by reason of the failure of the regulations to make procedure in respect to all business transactions perfectly clear.

The new regulations should not apply retroactively. They should be made effective for the taxable year 1929 and subsequent years, except where otherwise required by law. Procedure under existing regulations is fairly well established and understood with respect to practically all of the classes of taxpayers subject to the income tax law. Taxpayers generally would prefer to have their settlements for 1927 and 1928 made under existing regulations, which would give them a year or more to familiarize themselves with the regulations applicable to the taxable year 1929.

Successful Conventions

SUCCESSFUL conventions have far-reaching effects. There is no doubt concerning the success of the convention just concluded by the Western Division of the American Mining Congress. The attendance was large, and all sessions were attended by a majority of the delegates. The papers presented were clearly the result of much thought and effort and commanded close attention, bringing out much discussion of value.

The resolutions adopted show that the matters of greatest importance to the Western metal producer in maintaining the industry on a satisfactory basis are proper and intelligent methods of taxation, the sustaining of the tariff, stabilization of production, and cooperative effort on the part of the Government. The deliberations of the meetings showed the earnestness of the operator in solving his problems, and the cohesive and cooperative efforts being put forth in behalf of the industry.

RECENT DEVELOPMENTS *in the* MINING INDUSTRY

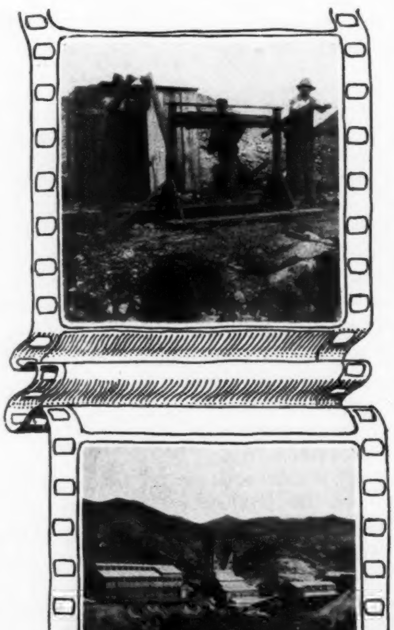
By HON. SCOTT TURNER*

A Survey Of Developments In Mining During Last Thirty Years, Including Improvements In Metal And Coal Mining, Mechanical And Electrical Machinery For Mines, Metallurgy, Petroleum Engineering And Safety Practice

THE general subject assigned me is "Recent Developments in Mining in the United States." By *recent* I shall mean within the past 20 or 30 years. Such a period includes a great many of the changes which are of particular interest to the present generation of engineers. In my review of developments, for the sake of simplicity and clarity, I shall deal separately with improvements in metal mining, coal mining, mechanical and electrical machinery for mines, metallurgy, petroleum engineering, and safety practices. Under each of these headings I have set down what appear to me to be the outstanding changes brought about during the past two or three decades. Other points will occur to other engineers; I do not represent that the following review is complete; it is only intended to be suggestive.

In general, improvements in mining and metallurgical practices have come gradually, the changes being effected little by little, simultaneously in widely scattered places, and through the experience and inventive genius of many men. These changes have had small beginnings, and are generally the cumulative result of many steady and unsensational progressions, which still continue. What we today might be inclined to consider the culmination of a series of betterments in mining is, of course, but an instantaneous phase of developments which will continue in the future at even a more rapid pace than they have in the past. We are looking at but a flash of a moving picture, with an endless reel to come after we finally leave the theater.

Behind all the changes in the mineral industry the driving force has been the increasing demand of an expanding population for more metals and minerals with which to advance civilization. More people, with an increasing per capita consumption, together with the exhaustion of the richer but smaller and more accessible mineral deposits, have required that the engineer exploit faster and on a larger scale the lower grade but more extensive reserves. To do this at reasonable cost has taxed his ingenuity in every direction. Advancing costs of labor, materials, and supplies, have necessitated improvements and refinements in practices, so a unit of metal or mineral may be produced with less labor and with fewer operating supplies. Better coordination and direction of work, elimination of duplication and other waste, and the multiplication of the work done per unit of man or other power, are means toward this end. In America this is all indicated by the so-called "speeding-up process," whereby it appears that the average workman in the United States now puts out 30 times as much as the average man in China, Russia, or India, almost 14 times more than the native of Italy or Japan, 8 times as much as the worker in Poland, more than 3 times as much as the native of France or Australia, 2½ times as much as the German, nearly two-thirds more than the workman of Great Britain, and almost one-half more than the Canadian, who is our nearest rival. Here we have the apparent anomaly of high wages and low costs, and this is important to remember in considering our mining industry. Bearing this general picture in mind, we may now turn to certain more concrete considerations.



"We are looking at but a flash of a moving picture, with an endless reel to come after we leave the theater"

In reviewing changes in metal mining, let us first consider the case of copper. From 30 years ago until the World War the average price of this metal was 14½ cents per pound; during the war the average was 24 cents, and since 1919 it has been 13.6 cents, or less than the prewar price. High war prices, coupled with urgent requests from the Allied Governments, resulted in production

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being pushed to a maximum, without much regard for the physical condition of the mines or the maintenance of proper ore reserves. The period from the beginning of the century to the first days of the war had witnessed the start and growth of operations at the large, low-grade, so-called porphyry properties, in which new methods of surface and underground mining had been developed. In the mines, shrinkage-stope, top-slice, and various other caving methods were employed. That was a time of steady and orderly improvement in mining methods. Then came the war and the scramble for rapid production, even at the cost of proper engineering practices; the result was a large copper output, but the end of the war, followed by a great drop in price of the metal, found higher-grade deposits depleted, mines and equipment strained or exhausted, wages and materials costly; the operator, to survive, had to turn at once to lower-grade deposits, which he was forced to work at decreased cost to meet low copper prices; against him were arrayed all the unfavorable factors enumerated above. Then came rapid readjustments and changes in methods, with the result that the American copper producer increased tonnages mined per man-shift, reduced costs by decreasing consumption of explosives, power, timber, and other supplies, and thus weathered the storm.

The producers of other metals went through more or less similar experiences, and the remarkable thing about it all is the way in which American mining engineers met increased labor and supply costs and low metal prices by ingenious methods for decreasing production costs.

Metal mining in the United States might be briefly reviewed by saying that the art was born in California in the early 1850's; took a long forward step in the 60's, when extraction from wide rich lodes in Virginia City, Nev., necessitated square-setting and filling instead of irregular timbering; progressed through the period when hand-steel miners carefully selected the smaller and higher-grade portions of veins, blasted them down on rawhides or canvas, carefully picked, sorted, and sacked the ore won in overhand stopes, waste-filled as in the common European method; then came machine drills, shrinkage, pillar, and similar stoping methods, top-slicing, caving, and finally block-caving and branch-raise methods as used in some of the big mines of today.

I can summarize what has been accomplished in mining no more forcefully than by giving a few illustrations of improved practice: One copper mine in Arizona produced 7½ tons of ore per man-shift in 1916; 8¾ tons in 1917; and almost 17 tons in 1926, with a dynamite consumption of 1/3 of a lb. per ton. Another Arizona copper mine increased its per-man-shift production from 4½ tons in 1923 to 10¾ tons in 1926. An opencut copper mine in Utah produced 11 tons per manshift in 1911, and by 1926, working with lower-grade ore, the production had been increased to 28¾ tons per man-shift. Only 1/10 of a lb. of explosives per ton was used. The average daily ore-output was nearly 47,000 tons. To meet high labor and supply costs, a gold mine in Alaska so improved its mining methods that over a period of years it has produced 47 tons per man-shift, using an average of only ¼ of a lb. of explosives per ton of ore.

These are examples of the best American engineers have done, but not the best they will do. Nowhere else in the world have such results been even approximated, except at American-operated mines in Chile.

In considering bituminous coal mining, it should be remembered that undercutting machines, replacing hand-picks, were first introduced about 1890, and that from 1890 to 1924 the average production per man per day had risen from about 2½ to over 4½ tons. Contemporaneously, the percentage of coal produced by under-cutting has risen from nothing to about 70 percent of the total coal mined. Other factors enter into this increase in each miner's productivity, but it is generally considered that under-cutting machines have, in the case of bituminous coal, increased the output per man-shift by at least 50 percent. Shooting off the solid in bituminous mines is steadily decreasing and is now restricted to about 11 percent of our total production.

Coal-loading machines are being rapidly installed, the quantity loaded having increased fivefold since 1923. The tonnage loaded by machines, however (10,022,000 tons in 1926), is still barely 2 percent of the total production, and thus, while their introduction is an interesting development, and one which may later have greater effects than are now apparent, their use can hardly yet be classed as an important element in coal production. I myself installed electrically-driven mechanical conveyors at long-wall faces in European coal mines in 1913, but the use of such conveyors has come more recently in this country.

Hon. Scott Turner

We have lived to see electricity largely supplant steam and compressed air underground. The mule is disappearing from the mines, and the operations equipped with electric haulage now produce 86 percent of the total output. Concrete is coming to be used largely, and in the past 25 years has replaced other materials for the construction of overcasts, stoppings, and mine portals. Steel tipples on concrete foundations now replace wooden structures on masonry footings. Roller bearings on mine-car wheels make transport easier, and solid-body cars handled by rotary-dumping devices are displacing end or side-gate cars. The panel system of mining, whereby large coal mines are opened by independent units, is making progress. Thirty years ago a 2,000-ton mine was a large producer, whereas today operations are tending toward a larger-unit basis, so that 5,000 to 10,000-ton mines are now not uncommon. Coal-cleaning is now receiving increased attention, and many refinements are finding their way into current bituminous coal-mining practice.

Anthracite coal mining at first sight seems to present a less favorable picture, for in the same period of 30 years the production per man-shift has only increased from 1.85 to 2.10 tons; there has been steady progress in engineering, but the natural conditions have grown vastly more difficult. In the last generation the average depth of workings has increased 77 percent and the average thickness of the beds mined is barely half what it once was. The volume of water to be handled has greatly increased, and many collieries have been driven from virgin coal to second or even third mining. The anthracite engineers have increased the percentage of recovery from as low as 40 percent in 1880 to a present average of 65 percent. These advances have been made possible by steady improvements in equipment, particularly the general introduction of electricity. Natural conditions have limited the use of cutting machines to about 2 percent of the output, but in the adoption of face conveyors the anthracite mines are ahead of the bituminous.

Especially significant has been the progress in anthracite preparation,

through increasing size of the breakers and the introduction of new methods of both wet and dry-cleaning of coal. Sales of the small sizes (including pea) have been built up from 23 percent of the shipments in 1890 to 35 percent in 1925.

In regard to general changes in mechanical practices at mines, I have before mentioned the increasing use of electricity. Electric power is now often brought from a distance, and there are fewer local fuel-burning plants; the flexibility of distribution of electric power is recognized. Electricity is used from the surface to the mine-face in coal mining, but no successful electrically-operated drill has been developed for use in metal mines, where rock-drills operated by compressed air still prevail. Hand-drilling in metal mines has gone out of fashion during my time, and the tendency in air-drills has been toward lighter and more powerful one-man drills; the heavy two-man drill of 20 years ago is now seldom seen. Loading machines frequently replace hand-shoveling in underground mines, and electric haulage is becoming more common; underground conveyors and mechanical scrapers are frequently used. Steam is still used for hoisting in most deep metal mines, while hoisting by electricity is being more used in shallow or medium-depth mines. Large-capacity centrifugal pumps, operating against high heads, are replacing reciprocating pumps. Huge steam or electric shovels have improved open-pit metal mining results, and made possible many of our large-tonnage operations. At one strip-pit in Montana the output of coal per man per day is 47 tons, or ten times the average in the underground mines. Even the mine blacksmith and machine shops have been revolutionized in the past 30 years; drill-steel is now sharpened by machinery, and delicate instruments control heat-treatments which make old-time tempering processes appear extremely crude. All mechanical equipment is now faster-moving than heretofore; higher speeds are noted in devices such as steam turbines, electric motors, turbine air-compressors, and centrifugal pumps. Oil engines for larger installations and gasoline engines for smaller plants are often seen at metal mines, replacing old wood-fired boilers. The mechanical equipment of all classes of mines is becoming more complex, and more skilled labor and better technical supervision are required.

In touching on recent progress in metallurgy, it should be borne in mind that mining and metallurgical developments are so intimately related that they are but component parts of the general movement toward improvement in the mineral industry. If advance in metallurgical methods had not been steadily maintained, progress in the art of mining would have been correspondingly curtailed. So dependent is our present civilization on metals, and so closely is our social progress interwoven with metallurgical achievement, that one can hardly discuss the advance of the art of metallurgy without dealing with the broader topic of the advance of mankind.

Within economic limitations, recent developments in ferrous metallurgy tend either toward increased quantity or improved quality. The former is the case with the iron blast-furnace, where by increasing the size and the mechanical perfection of the apparatus, greatly increased outputs have been attained; the same tendency is seen all the way to the open-hearth-steel plant. Quality products, such as new alloys or compounds having special properties, are increasingly in demand and exert industrial influences all out of proportion to their weight or volume. Iron alloys containing tungsten, chromium, molybdenum, cobalt, nickel and vanadium have all become of tremendous industrial importance since the beginning of this century; new methods of heat-treatment are also noteworthy.

In the non-ferrous field, various forms of water-concentration were in use at the beginning of the century. Sluices, buddles, jigs, vanners, tables and other forms of equipment were in general use for concentration or separation of various minerals. Then, less than 20 years ago, came flotation, that new magic of many variations; today more than three-fourths of our non-ferrous ore is treated by this method. This single improvement has made usable such vast tonnages of low-grade or complex deposits that an equivalent to a very large increase in our natural resources has been accomplished, and we are assured of large supplies of relatively cheap metals for a long time to come.

In the extraction of precious metals such as gold and silver, simple concentrating processes gave way to amalgamation, and this method in turn became relatively unimportant with the development of the cyanide process, which, although first patented in 1887, has been largely improved within the past three decades, so that modern practice has resulted in higher extraction at lower cost by saving both cyanide and precipitants.

In the fire-metallurgy of lead, preparation of the fine portion of the blast-furnace charge by sintering; saving of volatilized products by baghouse or electric precipitator; and better refining methods for lead bullion, are outstanding achievements.

Zinc metallurgy shows even greater advances. The retort, in which all zinc was produced until the world war, now has the electrolytic plant as a growing rival; in 1926, about 18 percent of the total new zinc was produced by the electrolytic process. The success of electrolytic zinc is due to the success of flotation in making rich zinc concentrates from complex ores; to the ease of handling residual products; and to the constant demand for processes involving less human labor. Improvements of retort-smelting have been few. More complete removal of the sulphur from the charge by roasting, the use of higher temperatures and of alloys to resist them, and the employment of sintering are typical betterments in retort-practice.

The reclaiming of various metals that have once been used is receiving much attention; the necessity for this has been generally recognized only of late years.

Copper metallurgy was probably improved more by the application of the Bessemer process to the treatment of copper matte, than by any other single change; after this we might list processes involving electrolysis. The great acid-leaching plants for oxidized ores, in which the dissolved copper is precipitated electrolytically, come at once to mind in considering late developments. Ammonia is also being used commercially as a solvent for copper.

The use of electricity in metallurgy has increased rapidly during the period in question; it has been applied to the refining of copper, lead, and the precious metals, as well as more recently to the metallurgy of zinc; the ferro-alloys were largely developed in the electric furnace, and in past years tin has been electrolytically refined. Aluminum is almost entirely a product of the electric furnace; the alkaline-earth metals and their alloys are other examples.

The last subdivision of the mineral industry with which I will deal is the production and treatment of petroleum. Here one of the outstanding achievements is the development of the cracking process, whereby gasoline and other volatile products can be won by cracking the heavier oils; this process was not used on a large scale until 1913, in which year a few thousand gallons were produced; in 1927, over 4¼ billions of gallons of gasoline were thus produced, or about 30 percent of the gasoline output of United States refineries for that year. Thus the automobiles are kept running without undue destruction of crude oil; if only straight distillation had been used in 1927, 426 million additional barrels of crude oil would have been run to the stills to produce the gasoline required, so this figure of 426 million barrels represents the crude oil actually conserved last year by the development of the cracking process. In this automotive age this is indeed a noteworthy betterment. (*Continued on page* 770.)

OUR SHARE *in the* NATION'S BUSINESS *

By DR. GEORGE OTIS SMITH †

Furnished Raw Materials To Industry Mining's Share In Nation's Business—Present Trend Toward Greater Efficiency Indicated By Mechanization, Utilization Of Gas In Oil Recovery And Cheaper Methods Of Mining Low Grade Ore.

NO ONE enjoys more than I the statistical approach, and I likewise confess to taking keen pleasure in translating machine-added totals into other figures that have more of a human appeal. This pastime is one common to many engineers and writers; indeed, here in America, where statistics grow to such incomprehensible size, it is a favorite indoor sport to devise mathematical metaphores for expressing plainly and forcibly the huge quantity of any commodity that may be under discussion. In the interest of driving the facts home and of clinching the truth after it penetrates the human understanding, we go far afield to find tools and methods. We attempt to visualize the consumption of razor blades by placing the annual output hypothetically end to end and projecting that procession of steel wafers across our broad continent or around the globe. Or the chewing-gum habit is translated into acre-feet of the luscious slabs put upon the market in the last 12 months.

In speaking today of the importance of the mining industry, I will resist any temptation to emphasize by such metaphors the real meaning of our industry's five and a half billion dollars of annual output, or by some graphic device to compare that figure with the value of the contributions of other industries to the Nation's wealth, or to contrast the outstanding growth of our industry with the less spectacular rate of increase of other industries, such as agriculture and manufacturing, or even to picture by long trains of loaded cars the high percentage of the railroads' burden of freight furnished by our mines, wells, quarries, and smelters.

Engineering is in essence quantitative, and the engineer must deal with exact figures when he plans and constructs. Engineering truths are not best expressed by adjectives, yet my wish today is not to attempt a quantitative measure of the dominant position of the mineral industry of the United States in the existing scheme of material things, but rather to seek a qualitative appraisal of what mining and metallurgical engineers are doing to promote and make secure our national progress. Statistics help when we wish to gage material prosperity, but they fail when we desire to determine what share the engineers have in adding to the happiness and welfare of our people.

The hunt for the earth's hidden treasure and the winning of that treasure after it is found is in itself a fascinating task, but the national significance of that task is that the mines supply the raw materials to industry. This is our share in the Nation's business—something truly fundamental. The attitude of the mining engineer toward his task is necessarily inspired by an appreciation of the constantly changing and ever-expanding demands of civilization for raw materials with which to fashion new structures, new machines, new tools, new masterpieces of art.

Nor is it enough merely to respond to these demands: the mining engineer must also realize the approaching limitations of supply. Optimism can not add a barrel or a ton to Nature's store of indispensable mineral fuels and ores, upon which we are making larger and larger inroads each year. I was glad to hear President Kelley, of the Anaconda Copper Mining Company, oppose those who profess unbounded faith in Nature's continued generosity to America, with the plain warning: "To those who state that 'America has just started' the uncontrovertible answer is that so far as our natural resources are concerned America is well on its way."

The fact that our country has outpaced the world in producing mineral fuels and most of the raw materials carries with it the obvious fact that our increasing speed is bringing us ever nearer the finish. Conservation—by which I mean use without waste—deserves to be a religion with mining engineers, not a religion to preach so much as a religion to practice. Practical conservation in a special sense belongs to the mining and metallurgical engineer. His is the responsibility to meet the demands of civilization. Dwindling supplies call upon the mining geologist to find other deposits, the mining engineer to make them available, the metallurgist to devise improved methods for higher recovery of values and for profitable handling of leaner ores—theirs is the joint duty to keep up the flow of raw materials to industry.

But efficiency in use as well as in production is an aim that appeals to engineers who have the vision of future needs. Saving coal and oil at our power plants serves both present and future generations—it means a lowered cost for today and an added supply for tomorrow. So, too, thrift in the use and reclamation of metals is becoming a country-wide habit. Fortunately, we are accumulating a working capital of the metals, which can give service to mankind again and again. The several reincarnations of copper mined and smelted 50 years ago and since then devoted successively to the arts of peace and war would make a theme worthy of a poet. Even the most prosaic man must be aroused to enthusiastic admiration when he sees the extent to which thrift in the use and

* Presented to joint meeting of the Western Division, the American Mining Congress, and American Institute of Mining and Metallurgical Engineers, Los Angeles, Calif., September, 1928.
† Director, U. S. Geological Survey.

reuse of metal is practiced in a great plant like that of the Western Electric at Chicago. No shred of copper wire or particle of oxide is too small to be salvaged that it may again help to transmit the human voice across the continent.

The present trend toward greater efficiency in the winning of the mineral commodities which form the stuff that civilization feeds on is exhibited in many and varied aspects; mechanization in coal mining, utilization of gas in oil recovery, cheaper methods in mining large bodies of low grade ore, new processes in mill and smelter. All these improvements furnish concrete evidence of technical advance for the benefit of man. Visit the Northern Pacific's coal mine at Colstrip, where a huge electric shovel increases the miners' productive power nearly 20-fold; watch the ever-improved mining operation at Bingham Canyon, where you will see the economic miracle of labor costs going down while wages go up; observe the new records being made in increased recovery at the huge Anaconda smelter; or compare present practice in several of the oil fields with past practice everywhere. All along the line, whether the resulting commodity is steel or gasoline, locomotive fuel or copper rods, better engineering practice is rendering a double service to civilization by lowering costs and conserving supply.

In all this advance I see also the tendency to place the mining industry on a more substantial and more permanent basis. I observe better working conditions in the mine and smelter and better living conditions in the mining community. Social progress is a logical accompaniment of engineering advance.

At its best, the mining and metallurgical industry is not a merchandising but a producing business—not selling but creating. And the competitive spirit that is back of these engineering advances does not originate in the market place. The present urge for improved practice, whether its fruitage is called efficiency or economy, comes rather from professional pride and corporate encouragement. The mergers and combinations of neighboring mines into a consolidated property furnish the incentive for comprehensive plans for savings in operation, and the executive who fails to make large use of such opportunities is soon outstripped by others who sense the true meaning of their part in the Nation's business.

It is the possession of a clear vision of the country's future and a fixed purpose to accept his responsibility linked with that future that give the mining engineer a unique opportunity for public service. With the facilities put at his command by some corporations, whose far-sighted executives realize and acknowledge the large obligation of big business to society, many engineers in so-called private employment have power to serve the public beyond that afforded to the Government scientists or technologists. Public service is a state of mind rather than a matter of payroll.

As one of those whose professional work has been wholly in Government employ, I would like to urge closer cooperation between Federal engineers and the much larger group of engineers who are more immediately connected with the business of winning the mineral wealth of the United States. The principal function of the two Federal bureaus connected with mining is investigative, and as such it can be directly contributory to the industry's welfare.

One small group of Government engineers, the mining and petroleum engineers of the Geological Survey's mineral leasing division, have a definite supervisory function, limited, however, to the production of mineral fuels and fertilizers on public lands leased for private operation. Their specific duty is to see that the terms of each lease are carried out, that the proper royalties are collected, and that the public interest is served in a broad way. But I like to emphasize the helpful cooperation and advice which our engineers are constantly giving to the lessees. A Federal engineer who by his practical knowledge assists a private operator to attain a greater production at less cost benefits not only that operator but the general public as well. When he helps to bring about safer working conditions for the miners he performs genuine service to humanity. When by advice against improper methods he prevents damage to the publicly owned deposits of coal, oil, or gas, he safeguards not only the public in its ownership but also the private operators in their investments for development. The interests of Government owner and private operator are common, not antagonistic.

The shortest definition of engineering I know is prosperity insurance. The mining engineer's task in a national sense is to provide for both present and future—to promote prosperity for today and to insure prosperity for tomorrow. No one has a larger part to play than he in the program of practical conservation in which Government and business must cooperate.

SURPLUS MILITARY EXPLOSIVES USED INDUSTRIALLY

More than 126,000,000 pounds of TNT and other surplus military explosives accumulated by the Government at the close of the World War have been used for industrial purposes, states Dr. Charles E. Munroe, Chief of the Explosives Division of the Bureau of Mines. These explosives have been expended in road building, in construction of dams and reservoirs, in draining swamps, in clearing cut-over lands and for other useful purposes which have added materially to the wealth of the Nation.

After the entrance of the United States into the World War, the Nation set about the production of military explosives on a scale never before undertaken, and this work continued with such acceleration that when the Armistice was declared the country was producing military explosives in quantities never before realized. There is little doubt, Dr. Munroe points out, that this developed capacity was a material factor in ending the war. A consequence, however, was the accumulation at various points in this country of enormous stocks of high explosives and propellents, whose safeguarding during storage and transportation constituted a serious and costly obligation, while entailing a menace to the communities near which the material was stored.

The Bureau of Mines, which had taken an active part in the technical research necessary to the production of military explosives on a tremendous scale, advocated the use of these great stocks of surplus explosives on governmental and industrial peace-time projects, pointing out the heavy expense that would be entailed for either the continued preservation or the destruction of these explosives. This suggestion met with much adverse criticism, great stress being laid on the fact that military explosives, and particularly TNT, never had been used industrially and were, therefore, unfit for such purposes. The Bureau, however, proceeded to demonstrate the suitability of these explosives for industrial purposes and issued several publications setting forth the results it had obtained in practice in the field and giving detailed instructions as to the best methods of use. The result was that this huge store of military explosives was diverted into useful peace-time purposes.

Recently the Bureau was informed that some 250 tons of this military TNT, stored for use near an important Federal project, had deteriorated into a dangerous condition and should be destroyed. An explosives expert was detailed to inspect this supply.

The results of the inspection and testing of the samples showed that the TNT was in first-class condition and entirely suitable for use as a blasting agent. It is gratifying, concludes Dr. Munroe, to find that TNT, which has disclosed such admirable qualities for use in blasting, is proven, from this test of storage for upwards of 10 years, to have excellent keeping qualities also.

STRATEGIC RAW MINERALS*

By Maj. A. H. Hobley †

The Stimulation Of Domestic Production Of Strategic Raw Materials Obviously Offers Most Satisfactory Solution To Problem Of Preparedness In National Emergency—A Statement Of Information Ascertained In Study Of Industrial Resources and Possibilities Of Strategic Minerals

THE United States is unusually well blessed in its supply of raw materials and is probably more self-contained in this respect than any other country in the world. There are, however, certain raw materials which must be imported in whole or part and which are highly essential for industrial purposes. As these materials are also important from the standpoint of national defense they have been given the name "Strategic Raw Materials."

Different reasons exist for the insufficient domestic supply of strategic raw materials. In some cases climate and soil are unsuitable and it is impracticable to compete with the more favorable conditions found in other countries. This situation exists in materials of a vegetable origin and includes such items as rubber, camphor, shellac, coffee, jute, quinine, opium, sugar, manila fiber and cocoanut shells. In other cases insufficient supply may be attributed to economic considerations, as of course it is not reasonable to expect industry to be willing to pay more for a material of domestic production than for one which it can obtain at a cheaper price from another source. This situation exists in the case of many strategic raw materials of mineral origin, the most outstanding of which, in the United States, are manganese, antimony, chromium, platinum, tungsten, nitrates, quicksilver, nickel and tin.

Obtaining a sufficient supply of strategic minerals for military purposes in the last war caused considerable concern and in most cases required the special consideration of the War Industries Board. The tremendous increase in demand for manganese is clearly indicated by the variation in price from $37.50 per ton in 1914 to $400 in June, 1917. Difficulties in obtaining a sufficient supply of this material resulted in the adoption of methods to encourage domestic production. By this means the production of high grade ore from American mines was increased from 2,600 tons in 1914 to 310,000 tons in 1918. The shortage in supply also required the extreme measure of compelling the steel trade to use 70 percent ore instead of the 80 percent standard of parity, thus making available a quantity of American ore of a type which had not been previously used.

Only a small quantity of antimony has ever been produced in this country because it is cheaper to import it from Europe and China. The principal use of this material is as an alloy with lead for bullet cores and shrapnel balls, and about 70 percent of the available supply was used in the United States' military program. A military shortage in this material was avoided by curtailing the amount made available to the public.

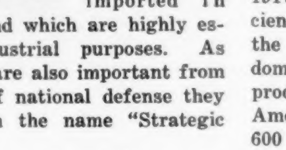
The principal military demand for chromium is as an alloy in steel used for armor plate and high speed tools, and thousands of tons were used for this purpose during the war. It is also used extensively in the manufacture of chrome brick for steel furnaces and as chrome salts for tanning leather. Before the war this material was obtained mainly from Australia, Caledonia and South Africa, but as a result of military necessity and governmental assistance, American industry succeeded in producing a sufficient quantity to materially decrease the necessary imports.

There is a very limited amount of recovered platinum in the world and Russia is the chief source of supply. This material is an essential in the contact process of making concentrated sulphuric and nitric acids, as well as for contact points of magnetos and as wire in thermo-couples. It is also irreplaceable in the chemical laboratory. Very stringent and positive governmental control was necessary during the war to prevent a shortage of this material.

Very strict economy was necessary to avoid a shortage of tungsten although this material was produced in quantity in the United States as well as imported. Its principal use was in high speed tool steel and other steel of special properties, and unusually large quantities were required in meeting contracts for making shells and guns for the Allies. Practically the entire output of the United States was consumed in direct or indirect war work.

The world's supply of nitrate of soda comes from deposits in Chile and special arrangements were necessary to avoid interference with the supply of this material which is used for the production of nitric acid, that most indispensable substance required for the manufacture of nitrocellulose powder and high explosives. Germany produced nitric acid by nitrogen-fixation processes, without which she perhaps, could not have carried on the war. America started three fixation plants, but none of them were completed before the armistice.

Quicksilver, or mercury, was used during the war in the production of the chemical salt known as fulminate of mercury, the detonating agent in cartridges, shells and grenades. Increased domestic production was insufficient to meet military requirements for this material, and imports as well as control of all supplies by the Government were necessary. (*Continued on page* 760)



* Presented to the First Annual Convention, American Manganese Producers Association, September 10, 1928, Washington, D. C.

† United States Army, War Department, Washington, D. C.

The TECHNOLOGICAL BRANCH *of the* BUREAU *of* MINES

By O. P. HOOD *

This Branch Now Consists of Seven Divisions, Including the Bureau's Interest in Explosives, Power Production, Petroleum and Natural Gas, Metallurgy and Mining, Also the Work Concerning Helium Production—This Branch Also Correlates the Work of the Eleven Major Experiment Stations of the Bureau

THE forces that operated to establish a Bureau of Mines could be grouped under three general heads. First, was the interest in conservation, accented in President Roosevelt's time, and partly expressed in the development of the Technologic Branch of the U. S. Geological Survey. Second, there was the humanitarian interest aroused by a series of terrible explosions that directed attention to the hazards of coal mining. Third, was a belief that the mining industry should have Government help similar to that given to agricultural industry.

While the idea of a general mine service organization would naturally include problems of conservation and of safety, the historical development of the bureau has been such as to accent these two factors above all others up to the present time. In the Technologic Branch of the Geological Survey the interest in conservation focused on the study of the fuel resources of the country with special reference to efficient use. There was, at the St. Louis and the Jamestown Expositions, operating units studying fuel problems. This fuels work is perhaps the oldest work of the bureau. When there was created a Bureau of Mines, there was added to this fuels work scientific and technologic studies of the causes of mine explosions. This work soon expanded to include matters of more general interest to the mining industry. The problems presented to the bureau were largely technologic in character, requiring for their solution a certain amount of scientific investigation. The bureau's staff was built up of technical people.

When the new organic act was drawn in 1910, the conception of a bureau, authorized to give service in the widest sense to the whole mining industry was uppermost in the mind of Director Holmes.

Operating under this act, the bureau continued to accent scientific and technologic investigations, and reached into other fields only as money became available. Appropriations were made for certain types of work, such as "mine accidents," "fuels investigations," "mineral mining," etc. This process of evolution is still in evidence. At first all of the work of the bureau could properly be classified as technologic and scientific, but with growth it has become necessary to divide the work into four general branches. Hence we have at the present time a Technologic Branch, an Economics Branch, a branch for Health and Safety, and an Administrative Branch.

The Technologic Branch contains much of the old bureau activity, with the exception of that closely related to health and safety. When a problem was started, it was assigned to an investigator, who became the head of a section, with usually a single problem on which he could concentrate. He was provided with one or a few helpers and he reported directly to the director. In 1911 the interests of the bureau had become so diversified that this simple organization was not sufficient. Sections dealing with similar professional work were grouped together, and the section heads reported to a division chief. For years these division chiefs reported directly to the director, until further complexity required the grouping of divisions into branches, with the division chiefs reporting to branch chiefs.

The Technologic Branch now consists of seven divisions. The bureau's interests in explosives is grouped in one division. A mechanical engineer, interested in power production and in machinery, directs a Mechanical Division interested in fuels and mine machinery.

There is a Division of Experiment Stations which correlates the work at the 11 major stations, which are so placed as to best serve the mining industry. There is a Division of Petroleum and Natural Gas, a Division of Metallurgy, and a Mining Division. The interests centering about the production of helium for the Army and Navy are grouped in the Helium Division.

The titles of these several divisions indicate, in general, the work in which they are interested. The least descriptive is, perhaps, that of the Experiment Stations Division. With the development of many scattered experiment stations a double system of control has grown up. For instance, the Metallurgical Division, interested in the metallurgy of zinc and lead, may have work in progress at the Mississippi Valley Station in Rolla, Mo., and also in connection with complex ores at the Intermountain Station at Salt Lake City. If stations were always monotechnic, they might be placed under a single division chief, but the work is continually shifting in accent, new problems are suggested as the result of local experience, several division chiefs may be interested in the work of any one station, so that a general correlating officer, dealing with all of the experiment stations as a system, has been found desirable.

Experimental blast furnace of the Bureau of Mines—the only successful one of its kind

MECHANICAL DIVISION

The mechanical engineer is particularly in-

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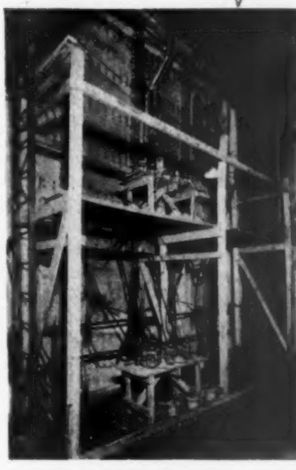
U. S. Bureau of Mines photographs.

terested in the efficient use of fuel in order that he may produce cheap power. The machines which use this power are also his special charge. The first grouping of sectional unit problems brought together the fuel and machinery investigations in a Mechanical Division. The organic act of the bureau made special mention of the study of the use of electricity in mines, since American mines are characterized by an extensive use of electricity.

It was for these reasons that the investigation of electrical machinery has been specially accented. The aid to the industry took the direction of the development of an approval system, designed to stimulate the manufacturer in the production of electrical equipment for use underground that would not ignite gas or dust if the machine were inadvertently brought into an explosive mixture. The development in America of such safe electrical equipment has taken place entirely under this system. As is well known, there is no compulsion of any kind in this matter, but the manufacturers of mining machinery have heartily cooperated with the bureau in the development and maintenance of this system which is relied upon by the operator to give him the best that the art affords. This work has involved research in several directions, such as the ignition of an explosive mixture of gas by sparks of various kinds, by heated metallic surfaces or glowing filaments such as may be exposed in broken electric lamps. A long list of approved electrical machinery is available as a result of this line of work.



Sampling furnace gases from a powdered coal furnace

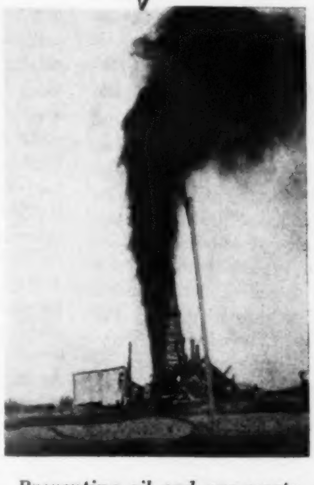
A few studies have been made in other lines of mining machinery, such as friction in mine-car wheels, the use of gasoline locomotives underground, etc., but the limited appropriations and the rapidity with which all other lines of work have grown have limited such investigations.

The bureau has conducted many investigations in the use of fuel. Combustion engineers were practically unknown 20 years ago. The general level of knowledge of combustion processes has risen greatly in the last 10 or 15 years, and in this field the Bureau of Mines has played a part. Perhaps the most conspicuous and effective has been the investigation of the combustion process as it proceeds from the surface of the grate up through the normal fuel bed and the completion of the combustion process from the surface of the fuel bed through the combustion chamber.

The development of the technique for such investigations has brought it into common use, in the field as well as in the laboratories. These studies have helped in the rapid evolution of furnace design as applied to power plants. These studies have been able to accelerate the development of the powdered coal furnace. Information was difficult to obtain regarding the results obtained by the use of powdered coal except from sources that had a commercial interest in the sale of this or that particular piece of equipment. Such information is always accepted with some hesitancy until accumulated evidence is overwhelming. The bureau was able, in its investigations, to authenticate certain high-test results obtained with powdered coal. A very rapid increase in the use of powdered coal followed the publication of these authenticated tests. The bureau has turned its attention to the transference of these improved methods of investigation and practice to other fuel-burning arts, such as ceramic kilns, industrial furnaces, blast-furnace practice, and house-heating equipment.

The bureau has maintained for many years a laboratory for the chemical analysis of fuels. Most of the commercial fuels of the country have been analyzed by the bureau and the results published. This includes analyses of thousands of mine samples of use to the geologist and the mine operator. There are also many thousand analyses of commercial coal as delivered which are used extensively by coal purchasers.

There is being conducted in the District of Columbia a survey of all the fuel-burning equipment of the Government, with an attempt to raise the general efficiency in the use of the fuel. This work is similar to the tuning-up process which any large industrial concern applies to its fuel-burning plants whenever economy in the use of fuel becomes an essential. Notable savings have been made, and there is still room for much improvement.



Preventing oil and gas waste is an important study of the Bureau

Investigations have lately been made concerning fuel available for the gas industry on the Pacific Coast, and an investigation just completed deals with the use of propane and butane in the manufactured gas industry as a substitute for the gas oil now in use.

The bureau is carrying on investigations in the clinkering of coal ash; in the conditions that refractories must stand in boiler furnaces; in the relative availability of different kinds of coke for use in domestic heating equipment; in the rating of low-pressure heating boilers; on the use of various salts for the removal of soot.

Along with technologic work of this kind scientific investigations of a more fundamental character are going on under the more immediate direction of A. C. Fieldner. A mere catalogue of these investigations will serve to indicate their trend. A study of the relation between combustion and the oxidizability of coal; the chemistry of decay in relation to peat and coal formation; the production of synthetic motor fuel from water gas; the constitution of certain low-temperature tars; the determination of re-activity of coke in air, carbon dioxide and water vapor and at various temperatures; a study of the equilibrium conditions and the action of catalysts in the synthesis of methane and motor fuel from water gas; hydrocarbon synthesis from water gas; equilibrium conditions in the formation of methanol from water gas; spontaneous combustion of coal; and other similar problems.

It is on such more or less abstruse investigations that applied technology rests for its advance in the more efficient use of natural resources.

The Petroleum and Natural Gas Division

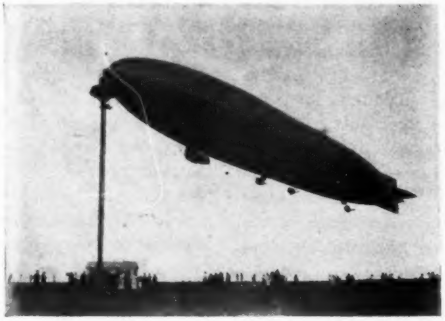
The Petroleum and Natural Gas Division of the Bureau of Mines conducts technical studies in the following branches of the oil and gas industry; drilling and production, transportation and storage, refining, petroleum chemistry, natural gas, natural gas gasoline

and oil shale. This work is in charge of Mr. H. H. Hill. In order to handle this work to best advantage the Division has established field offices and laboratories in or near the oil-producing districts, an experiment station being maintained at Bartlesville, Okla., and field offices at Dallas, Tex., Laramie, Wyo., and San Francisco, Calif., and an oil-shale laboratory at Boulder, Colo. In addition to the funds provided for this work by the Federal Government, cooperative funds are furnished by the States of Oklahoma, Colorado, and Wyoming and by such organizations as the American Petroleum Institute and the Natural Gas Association. At present the organization, including those paid from cooperative funds, consists of 77 employes, of whom 52 are technical men.

The bureau's work has for its purpose the elimination of waste in the production and transportation of petroleum and natural gas and the more efficient utilization of these raw materials in the manufacture of finished products. In a short paper of this kind it would not be possible to discuss all the different studies that are being conducted, but a few examples will illustrate the type of work that is being carried on.

The early work of the division consisted to a large extent of calling attention to the wastes of oil and gas that resulted from the improper drilling of wells. Engineers made a study of the savings that could be made by the use of mud fluid and cement, and experienced drillers were employed to demonstrate the methods that should be followed in controlling high-pressure gas and for shutting off water in the wells. This work has been expanded to include detailed engineering studies of a number of fields for the purpose of preventing the encroachment of water and increasing the recovery of oil. It is generally recognized that water is the oil producer's worst enemy, for it increases the cost of lifting the fluid, may corrode tubing and casing, or form emulsions with the oil, and finally, if not brought under control, will flood the oil sand and completely ruin the property. It is important, therefore, to prevent the encroachment of water in order to obtain the maximum recovery of oil.

An extended study is now being made of the problem of increasing the recovery of oil by restoring pressure to the partially depleted oil sands. The various factors governing the flow of oil and gas through the sands are being studied and a large number of tests are being made to determine the relative efficiencies of air and gas as a means of driving the oil to the wells. Since a number of authorities are of the opinion that not more than an average of 20 percent of the oil originally contained in the sand is recovered by present methods of flowing and pumping, this investigation is of immense interest to the oil industry. At the present time there are more than 300,000 producing oil wells in the country with an average production of about 8 barrels a day. Approximately half of the oil being produced is coming from 2 percent of the wells and 200,000 out of over 300,000 wells produce only 125,000 barrels of oil a day, an average of 0.6 barrels per well. The question of increasing the production of these small wells is doubtless the most important problem that confronts the oil industry.



The bureau is making a thorough study of the sulphur compounds that are present in crude oil and in refined petroleum products. Sulphur is to the refiner what water is to the oil producer in that it is about the most troublesome substance with which he has to deal. Sulphur compounds in crude oil cause corrosion of refinery equipment, and their presence adds to the difficulty of producing refined products that meet the specifications for color, odor and absence of corrosive products. Since the crude oils produced from some of the most important new fields contain relatively high percentages of sulphur, the problem of determining the constitution of the sulphur compounds, their removal and possible utilization is becoming of increasing importance.

One of the most important investigations of the Petroleum Division has been a study of the evaporation losses of crude oil on the lease, during transportation, and while stored over long periods of time. The first report on this problem called attention to the fact that the average evaporation loss of Mid-Continent crude oil from well to refinery amounted to 6.2 percent, which represented a total annual loss of about 500,000,000 gallons for that district. Other studies called attention to the savings that could be made by the installation of gas-tight tanks, and, as a result of these investigations, improved equipment for reducing evaporation losses is in general use today.

The Petroleum Division has been making laboratory studies of oil shale over a period of several years, and, starting in 1925, built and operated an experimental oil-shale plant in order to determine the possibilities of extracting oil from oil shale on a semi-commercial scale. The retorting plant is now shut down, due to the failure of Congress to provide funds for its operation, but refining studies of the shale oil produced are being continued at the Boulder laboratory.

Activities of the Helium Division

The Government's helium project was conceived as a wartime necessity and goes back practically to our entrance into the World War. Helium had been found in natural gas in 1905, and the feasibility of using this source of supply for lighter-than-air craft in the Nation's defense originated with a member of this bureau. The suggestion was taken up at once by the Army and Navy, and all of the funds for carrying on the various helium projects and activities were made available from Army and Navy appropriations. Full cooperation was established between the Bureau of Mines and the Army and Navy for conducting the work. The great majority of the engineering and the research investigations were conducted under the direction of the Bureau of Mines. Since helium production presented a pioneer research problem, under the urge of speed for wartime use, experimental plants, operating on several trial systems, were constructed and rushed to completion, under the general supervision of the Bureau of Mines. These plants produced, all told, about 300,000 cubic feet of gas up to the signing of the Armistice, when, their purpose of furnishing workable data upon which a production plant might be constructed having been served, they passed out of existence, their equipment being sold or utilized elsewhere in the service. Based on the experience thus gained, a multiple-unit production plant was then constructed under cognizance of the Navy Department on a Government reservation of approximately 28 acres, just outside Fort Worth, Tex. This plant is known as the U. S. Helium Production Plant No. 1, and has been producing helium ever since.

It is this plant that has been furnishing the helium gas used in the *Los Angeles*, the late *Shenandoah*, and other Government airships and balloons. It was thought, however, that the initial operating costs and efficiency reached in this plant might be materially bettered. A special board composed of distin-

guished technical men, and known as the Board of Helium Engineers, was therefore organized, under the authority of the Bureau of Mines, to take under advisement the problem of low-cost helium production, with the result that, step by step, founded on exhaustive study and careful research investigations carried out in the Cryogenic Laboratory of the Bureau of Mines, a laboratory-size and then a semicommercial-size production plant were evolved and built under the direction of the bureau's engineers for the purpose of trying out new plans and designs. Very gratifying results were obtained. The experience gained, supplemented by later data developed by bureau engineers, pointed the way for the design of a full-size production plant, which had been constructed at the site of Production Plant No. 1 and has, for some time, been operating on trial runs, with very satisfactory results. This unit is known as U. S. Helium Production Plant No. 2.

Helium in commercially important amounts has been obtained, so far, only from certain natural gases, and during all the time the already-mentioned activities have been in progress the Bureau of Mines has maintained a comprehensive survey of the country's natural gases for helium. Over 2,000 samples from gas wells located in over 30 States have been examined for helium content, and records of the results are kept. This investigation is still in active progress and forms a vitally important part of this division's work, for it is obvious that upon the maintenance of an adequate and constant supply of helium-bearing gas, this whole activity depends. An entire section of this division is devoted to this work.

On July 1, 1925, pursuant to the act of March 3, 1925, entire responsibility for helium production was placed in the Bureau of Mines with authorization to explore for, produce, and store and care for helium and to purify it after use in airships; and all production plants were transferred to this bureau. This was done to head up the helium activities under one agency, instead of having them scattered among several, with divided authority and consequent lack of efficiency and economy. The Bureau of Mines was selected for this purpose, since it was the obvious thing to do, this bureau having been and still continuing to be the prime mover in the helium project, and the majority of the work in connection with it having been carried on under this bureau's authority.

An idea of the magnitude of the helium project may be gained from a brief summary of the activities with which the Helium Division is charged, as follows:

A constantly patrolled 10-inch gas-pipe line, approximately 100 miles long, extending from the Petrolia gas field, in Clay County, Tex., to Forth Worth. The Bureau of Mines, under contract with the Lone Star Gas Co., has the first call on the use of the gas from this field for helium extraction purposes. The average helium content of this gas is approximately 0.94 percent.

A five-unit production plant, Production Plant No. 1, occupying about 28 acres of Government-owned land at Fort Worth, Tex., embracing buildings, equipments, facilities, and adjuncts, such as water wells, cooling pond, roads, paving, trackage, etc. This plant has processed up to more than 5,000,000 cubic feet of raw gas per day, producing at one time helium at the rate of more than 1,000,000 cubic feet per month, at an average cost of $28 per thousand cubic feet. The capacity of the pipe line conveying to it natural, helium-bearing gas for processing, under conditions of gas pressure when the line was built, was about 9,000,000 cubic feet per day. The full capacity of pipe line and plant have not been realized by reason of the inadequacy of the gas supply from the source in the Petrolia gas field. The Linde Air Products Co. cooperates, under contract, in the operation of this plant, the process employed being developed by the Linde Company.

O. P. Hood, Chief, Technological Branch, U. S. Bureau of Mines

A small-size experimental helium plant, already spoken of, was installed in a part of the building located on the above-mentioned acreage. This plant was designed by the Board of Helium Engineers for a production capacity for processing about 600,000 cubic feet of raw gas per day, separating 3,000 to 5,000 cubic feet of helium. This plant, placed in stand-by condition, is reserved for further experimentation, as required.

A production plant of one initial unit, already referred to as Plant No. 2, now constructed, of a different design from the Linde plant, estimated to handle 3,000,000 cubic feet of raw gas per day, with a recovery of about 24,000 cubic feet of approximately 96 percent helium.

The bureau's engineers have designed and superintended the construction of three helium purification plants, as follows:

For the Navy, a stationary purification plant at its Lakehurst, N. J., station, for the purification of helium after use in airships, whereby it becomes contaminated by air by leakage through the fabric of the gas cells. This plant was designed to handle 10,000 to 15,000 cubic feet of helium of 80 percent purity per hour, raising it to 98 percent. It has been in successful operation since it was turned over to the Navy, July 1, 1924, and, in fact, has played an important part in keeping the Navy's dirigibles in the air, especially in view of the inadequate supply of helium now available, as explained elsewhere.

The bureau has designed for the Army, constructed and officially turned over to that service as of July 1, 1927, a smaller mobile purification unit of the Lakehurst type, mounted on a specially designed railroad car, which is now stationed at Scott Field, near St. Louis, in successful operation. This plant was designed to have a capacity of about 5,000 cubic feet of helium per hour.

Finally, the bureau has designed and is at present engaged in superintending the construction of a stationary purification plant for the Army, at Scott Field, of the same general type as the two above, to have an immediate capacity of 10,000 cubic feet of impure helium per hour and double this by adding an additional compressor unit.

A cryogenic, or low temperature, research laboratory is established at the bureau's Pittsburgh station, in which scientific and engineering problems relating to helium production and purification are worked out in theory and experimental practice. This laboratory has employed, at one time, as high as 23 men. It is the only laboratory of its kind in the world. The value of such scientific experimentation is proven by the fact that helium, costing before the war about $2,500 per cubic foot, is now being produced for between 3 and 4 cents, and, as above set out, it is expected to reduce this figure still further.

A gas analytical laboratory and a field force to explore the country's helium-bearing gas resources are in operation with headquarters at the Production Plant, Fort Worth. Natural gases of interest to the Government on account of helium possibilities are tested and methods for the proper conservation of such gases are devised.

As has been indicated above, the source of helium-bearing, natural gas from the Petrolia field now supplying the production plant at Fort Worth is inadequate to furnish sufficient helium for Government uses. This was the only

field known containing sufficient quantities of natural, helium-bearing gas for large-scale production when the production plant was built. The field was then 20 years old, and its resources were greatly depleted by usage for commercial fuel purposes. The Bureau of Mines has, therefore, in connection with its investigations relating to helium exploration and conservation, been conducting negotiations for the acquirement of further supplies of raw material from other fields. While it is confidently expected that these negotiations will soon lead to a successful solution of the problem of a Government helium supply for at least a good while to come, they have not yet reached a stage that will permit of further details being given at this time. It may be said, however, that the source or sources of supply are located in northwestern Texas.

Too much emphasis can scarcely be placed on the importance of helium production. Helium is the only known gas light enough for aviation purposes that is absolutely noninflammable, thus insuring against fire hazard in airships, which is the greatest danger inherent in hydrogen-filled craft; a peril not only to the ship but to the valuable lives of those on board. Helium is, therefore, of transcendent importance in war, of immense value in peace for aviation purposes, and research is teaching us that it has other applications, the importance of which we are just beginning to glimpse. The United States is the only country now known to be favored with stores of helium of commercial importance, but, as has been said, the helium is contained in certain natural gases. They are in ordinary use for heating and lighting, and the helium is therefore being wasted in the consumption of these gases to an extent of billions of cubic feet per year. This loss can never be made good; the helium once gone cannot be recovered. It therefore behooves the Government to speed up in every possible way helium exploration, conservation, and production in the interests of national defense and to pave the way for commercial production and utilization to follow.

Value of by-products and of coke, including breeze, per ton of coal consumed in by-product plants in the United States in 1927 was $8.95, compared with $9.17 in 1926, $8.86 in 1925, and $9.27 in 1924. The post-war record was $10.33 in 1923. In 1927 an average ton of coal charged in by-product ovens yielded 1.388 pounds of coke, 8.6 gallons of tar, 22.7 pounds of ammonium sulphate, 2.9 gallons of light oil, and 11,100 cubic feet of gas, according to figures published by the United States Bureau of Mines.

STRATEGIC RAW MINERALS

(Continued from page 755)

Nickel steel is used in armor plate and other ordnance material, engine forgings, shafting, railroad rails, structural work, bridges and in many other items requiring high physical characteristics. It is also the principal element in monel metal which has been found to resist successfully the corrosive effect of salt water, and which is used extensively for propellers and propeller shafts of warships. The war required directly or indirectly nearly 90 percent of our nickel supply, practically all of which came from the International Nickel Company.

The principal tin ore deposits are in the Federated Malay States, although large quantities were imported into this country, during the war, from Bolivia. The chief use for tin is in the manufacture of tin plate for containers of various kinds, tin being used as a protective coating for iron and steel sheet to prevent rust. Large quantities are also used in solder, bearing metals, brass and bronze. An inter-allied agreement was necessary to provide for the control and distribution of tin to meet the requirements of the war.

In view of this country's experience in the World War and in accordance with the requirements of the National Defense Act, a study is being made of the industrial resources and possibilities of the country as they relate to war needs, with a view to determining the steps to be taken to insure preparedness for a national emergency. In the case of strategic materials, three lines of action are available:

(1) The stimulation of domestic production.

(2) The accumulation of a war reserve stock.

(3) The substitution of a domestic material available in sufficient quantity.

If domestic production can be increased sufficiently to meet the demand, this method obviously offers the most satisfactory solution. Even where the raw material is available in this country, however, this method is subject to good economic judgment and also to analysis from the standpoint of the wisdom of exhausting available supplies known to exist only in small quantities. Clearly, little success could be expected of an effort to establish a nickel mining industry in the United States, if, in order to do this it would be necessary to sell nickel at a price much greater than it can be obtained from Canadian sources. As minerals do not ordinarily deteriorate in storage, the accumulation of a war reserve stock offers a practicable solution, but is open to the objection of the cost involved. A sufficient reserve would involve the expenditure of a considerable sum and should only be resorted to after the exhaustion of all other measures.

Considerable work has been done in attempting to develop substitutes for the more important of these strategic materials and reasonable success has attended some of these efforts. For instance, it has been determined that Frary metal, an alloy of barium and calcium with lead, is a satisfactory substitute and can be used for replacing antimonial lead for many purposes and thus considerably decrease the requirements for antimony. Tungsten has been found quite satisfactory for replacing platinum in electrical contacts. Experimental work to date indicates a possibility of the substitution of manganese molybdenum for tungsten in tool steel and a similar steel possesses value for replacing nickel steel in gun forgings. The critical situation in nitrates will probably be entirely removed in a short time by the further improvement and development of the nitrogen fixation process. Thought and study is being given to the problem of assuring a substitute for tin and it is very unlikely that any serious embarrassment would be caused in a future emergency by a shortage of this material.

The development of suitable substitutes for strategic minerals is necessarily a slow and tedious one, in view of the nature of the problem and the necessity for thorough tests under all conditions to which articles manufactured from the resulting substitutes must be submitted. For instance if a substitute for tin is under consideration, it must be determined whether food in tinless containers will stand the rough usage to which they would be subjected by shipment through various parts of the world and whether food in such containers would be as satisfactorily preserved under extreme climatic conditions, as in the present tin cans.

That the subject of strategic materials requires continuous study is quite evident. For instance, in the last war Irish linen was considered quite indispensable for covering airplane wings. Anticipated difficulty in obtaining a sufficient supply of flax to meet the expected demands for linen, soon indicated the necessity for endeavoring to develop a substitute material. In the course of a very short time the United States was successful in developing a cotton fabric which was even more efficient for the purpose originally served by the linen, and the adoption of which resulted in eliminating entirely any further concern regarding a sufficient supply of linen.

Continuous study and consideration of strategic materials will undoubtedly eventually result in the development of substitutes for many of them which could be used, in time of a national emergency at least if they were not entirely satisfactory for ordinary commercial purposes.

SIXTH ANNUAL MEETING OF WESTERN DIVISION

By GUY N. BJORGE *

Western Division, American Mining Congress, American Institute of Mining Engineers and Mineral Committee of California Development Association Hold Joint Meeting— Program Presented of Exceptional Interest — Frank M. Smith Elected Chairman

Frank M. Smith, Chairman of the Board of Governors

MINING men from all of the Western States gathered in Los Angeles, September 10-13, for the Sixth Annual Meeting of the Western division of the American Mining Congress, which was held jointly with the Regional Conference of the Western Sections of the American Institute of Mining and Metallurgical Engineers and the Mining Section of the California Development Association. The program presented covered economic and legislative questions affecting the metal mining industry and also its technical and operating problems. The large attendance at all of the sessions in spite of the numerous and varied counter attractions testified to the exceptional interest of the program.

The meeting was called to order by Philip Wiseman, governor of the Western Division of the American Mining Congress, who said:

"It has been the practice of the American Mining Congress to hold four meetings annually throughout the country. It happens that this year Los Angeles has been chosen as one of those places. And in making this arrangement it was possible to have a joint meeting with the American Institute of Mining and Metallurgical Engineers and the Mining Section of the California Development Association.

"The activities of these organizations have been devoted very largely to the spread of knowledge regarding mining and metallurgy, and bringing to the attention of capital the natural resources of the country; also in the standardization of methods of mining and in the standardization of machinery. A great deal of attention has also been given to the question of the conservation of what is known as our 'wasting' products.

"Another line of activity has been the enactment, or rather, seeking the enactment of equitable legislation for the producing companies. In the last 25 to 30 years very remarkable progress has been made, particularly in mining and metallurgy. There is this peculiarity about our mining companies in this respect: That while they are in a sense competitive, they are not 'competitive' in the ordinary use of the word; consequently, there has been a very great spread of the knowledge which has been gained by any particular man or any particular company. I think it is a very happy thing that such has been the case.

"It is not unusual for a man, when he feels that he has achieved something along his particular line of work that is a little in advance of what others are doing, to feel very well satisfied with himself; and he may even go to the point where he feels that he has reached the pinnacle of achievement, but it has been my own observation that when a man reaches that state of mind he is very apt to be at the point of slipping, and if he is not willing to still continue to devote his time and attention to his problems and find out what other men are accomplishing, he will very soon be back in the rank and file.

"Many papers are to be read at this meeting. It seems to me that most of you will find them to be of great interest and most profitable. If, however, you have reached that point in your work where what you are told of here is not new to you, we hope that you will at least be willing to join in the discussions and let others know what you have been doing.

"It is, therefore, with a great deal of pleasure that I welcome you here in behalf of the American Mining Congress, the American Institute of Mining and Metallurgical Engineers and the Mining Section of the California Development Association. I hope that you will have a very profitable and a very enjoyable time."

The present state of the mining industry was briefly summarized in three-minute responses from representatives of the Western States.

A. G. Mackenzie, speaking for Utah, paid particular attention to the development of the zinc industry in Utah as a result of the application of selective flotation. Zinc production from Utah has broken past records each year since the first commercial plant for the separation of lead and zinc went into operation.

J. O. A. Carper, of Colorado, introduced as the "Dean of the Sow Belly Dinner," spoke of the initiation of the first Sow Belly Dinner in Denver and of the progress in the mining industry for which that annual gathering has been responsible. Following the first of these dinners a "prospecting committee" was organized and 2,000 maps to aid prospectors were distributed. This served to stimulate prospecting and, together with the development of selective flotation, has served to revive mining activity in Colorado. The safety and profit in mining business when financed and directed in a capable business way was emphasized.

J. D. Conover, representing the Tri-State district, discussed present activities in that district. He said that predictions as to the probable short life of the Picher area had not been fulfilled and that the district would continue producing for many years. At present, production in the Tri-State district is being curtailed because of the low price of zinc. He stated that this district was the only large lead-zinc district that is operating below capacity. If other districts would follow this lead, increased metal prices would soon result.

G. Chester Brown, of San Francisco, emphasized the progress made in the development of the commercial mineral industry in California. This development has been rapid, particularly in southern California.

W. B. Gohring, representing Arizona, spoke of the stability of mining in that state. With the large copper producers, business is getting to be almost as stable as in the manufacturing industry.

* Associate Editor, Mining Congress Journal.

Frank M. Smith, of Spokane, gave an interesting resumé of the progress of mining in Idaho. A notable increase in the production of lead and zinc has been made in spite of the lower prices for these metals. The starting up of the new zinc plant near Kellogg marks the beginning of a new epoch for the Coeur d'Alene district, as it supplies a market for the so-called "base ores" of the area.

J. C. Kinnear, of Nevada, said that Ely, the main copper camp, is on a sound, healthy and prosperous basis. Operators in the smaller districts are diligently and intelligently prospecting and developing, but operations are not as large as in the past. Nevada needs new discoveries. It needs something to stimulate and to help those that are now operating.

J. F. Woodbury, of New Mexico, expressed the opinion that that State was on the eve of rapid and rather extensive mineral development. This activity is accounted for to some extent by important legislation affecting mining passed by the last legislature. He said this was the first time that the State government had paid any attention to the mining industry except to tax it. Development in the lead and zinc industry has been marked by the opening of four mills to treat lead-zinc ores.

Milnor Roberts, Dean of the Mining School of the University of Washington, analyzed the metal mining industry of Washington. Washington has no large single district, but there has been a steady increase in the production from small mines.

The keynote of the meeting was given in the thoughtful and inspiring address on "The Needs of the Western Metal Mining Industry," by Charles W. Merrill, of San Francisco. This will appear in full in the November issue of the JOURNAL.

A. I. M. E. SESSIONS

The afternoon session on the opening day was under the auspices of the American Institute of Mining and Metallurgical Engineers, with Dr. E. P. Mathewson, of the University of Arizona, presiding.

Martin Van Couvering, Petroleum Engineer of Los Angeles, gave an interesting discussion of recent attempts at Natural Gas Conservation in California. Natural gas production resulting from petroleum development has greatly exceeded possible consumption and immense quantities have been wasted. Recently, concerted efforts by the producing companies with the cooperation of the State government are showing important results in preventing this waste. The storage of natural gas in sands below ground is a new experiment, and the results attained when this stored gas is recovered will prove highly interesting.

The paper by J. B. Tenny, Geologist, Arizona Bureau of Mines on "Why Not an Electrolytic Zinc Plant for the Southwest," aroused especial interest. Mr. Tenny gave a very thorough analysis of the problem, and clearly showed the opportunity for such a plant to provide a market for the growing zinc production of the Southwest. He stated that cheap fuel would be one of the controlling factors in selecting the location for such a plant. The preceding paper, telling of the overproduction and resulting waste of natural gas in southern California, seemingly presented a solution for this problem.

As C. A. Mitke was unable to be present, F. W. Maclennan, General Manager, Miami Copper Company, was called on as a "pinch hitter," and gave an exceptionally clear and well-connected impromptu discussion of Block Caving methods at the Miami mine. Frank Ayers discussed caving methods at Morenci and wherein their problem differed from that at Miami.

David Hall, General Engineer, Westinghouse Electric and Manufacturing Company, Los Angeles, gave an interesting paper on "High Efficiency Motor Generator Sets for Leaching Plants." This was a description of the installation at the Inspiration leaching plant and of the operating results attained.

Irving A. Palmer, Professor of Metallurgy at the Colorado School of Mines, presented a discussion of progress in the application of "Flotation."

A second session under the auspices of the American Institute of Mining and Metallurgical Engineers, held on Wednesday afternoon, had development of nonmetallic minerals as its principal theme. The session was presided over by Robert Linton, General Manager, Pacific Clay Products, Los Angeles.

R. R. Boyd, chairman of the Los Angeles section of the American Institute of Mining and Metallurgical Engineers, in a few well-chosen words welcomed the visitors in behalf of that section and introduced George Otis Smith, President of the Institute, who spoke on "Our Share in the Nation's Business." He painted a graphic picture of the importance of the mining industry and the part it should play in the business of the Nation.

George J. Young, Associate Editor, Engineering and Mining Journal, San Francisco, spoke on the "Possibilities of Non-Metallic Mineral Development in the Pacific States." This included an analysis of the present state of the nonmetallic industry, the minerals now being produced and the districts that yield the principal production, with a discussion of the possibilities for further development.

Walter W. Bradley, State Mineralogist of California, in a paper on the "General Occurrence of Non-Metallic Minerals Throughout the State of California," gave a comprehensive resumé of the occurrence of such minerals in the State. He discussed the minerals that are now being produced, and stated that each of the 58 counties in the State can produce at least one of these minerals and 1 county can produce all.

C. W. Davies, Chemist, Bureau of Mines at Reno, in a paper on "Some Properties of Oil Bleaching Clays," gave a lengthy and detailed discussion of the properties of such clays.

W. F. Dietrich, Associate Professor of Mining Engineering at Stanford University, discussed "Clay Mining Methods in California." He gave a clear description of methods now employed at the clay pits with large and small production, and pointed out opportunities for improvements that might to a greater extent do away with hand labor.

DISCUSSION OF OPERATING PROBLEMS

Two sessions held under the auspices of the Western Division of the Mining Congress were given over to a discussion of "Operating Problems." The morning session on Tuesday, September 11, was presided over by Guy N. Bjorge, Consulting Geologist and Engineer of San Francisco and Associate Editor of THE MINING CONGRESS JOURNAL. Papers were as follows:

"Underground Mine Ventilation Problems at the Copper Queen," by J. B. Pullen, Copper Queen Branch, Phelps Dodge Corporation.

"The Use of Scrapers in Underground Loading at the Ruth Mine," by Chas. F. Steinbach, Nevada Mines, Nevada Consolidated Copper Company.

"Revisions in the Coarse Crushing and Fine Crushing Departments of the Hurley Plant," by Fred Hodges, Superintendent of Mills, Chino Mines, Nevada Consolidated Copper Company.

At the morning session on Wednesday, September 12, presided over by Frank M. Smith, Smelter Director, Bunker Hill and Sullivan Mining and Concentrating Company, Spokane, the following papers were presented:

"The Supply Department," by A. J. MacLean, General Purchasing Agent, Utah Copper Company.

"The Mine Manager's Cost Control Problem," by T. O. McGrath, General Manager, Shattuck Denn Mining Corporation.

"Cooperative Mining Development," by James W. Wade, Assistant General Manager, Tintic Standard Mining Company.

"Diesel Engines as a Souce of Power," by H. H. Pratt, Chief Mechanical Engineer, Phelps Dodge Corporation.

"The New Central Power Plant of the

Commerce Mining and Royalty Company," by George J. Stein, Chief Engineer.

"The Preparation and Modification of Ore Pulps in Flotation," by H. S. Martin, Metallurgist, Utah Copper Company. The same subject was discussed by Arthur Crowfoot, Mill Superintendent, Morenci Branch, Phelps Dodge Corporation, without any prepared paper.

Most of the above papers were published in full in the September issue of THE MINING CONGRESS JOURNAL. The remaining papers will be found in this and succeeding issues of the JOURNAL. No synopsis of these papers will, therefore, be given here. The discussion of these papers yielded much interesting and valuable information. Parts of this discussion will be given in later issues of the JOURNAL.

CALIFORNIA DEVELOPMENT ASSOCIATION

The afternoon session on Tuesday, September 11, was under the auspices of the Mineral Committee of the California Development Association. This committee was organized to correlate and consolidate the work of the numerous agencies in the State working for progress in the Mining Industry. The work of the committee has been divided into four branches, each directed by a State chairman. These are as follows:

Research.—Theodore J. Hoover, Dean, School of Engineering, Stanford University.

Legislation.—William E. Colby, Attorney, San Francisco.

Market Development.—J. M. Hill, Consulting Engineer, San Francisco. Formerly in charge of Division of Mineral Resources, U. S. Bureau of Mines, San Francisco.

Publicity.— Frank H. Probert, Dean, College of Mining, University of California.

The session was presided over by Charles W. Merrill, Metallurgist of San Francisco. The program gave an illuminating picture of the work of the Mineral Committees of the Development Association.

"Mineral Development in Southern California" was discussed by Rush T. Sill, Consulting Engineer of Los Angeles. This was a most comprehensive review of mineral development, both metals and non-metals, in the southern portion of the State.

A prepared statement on the "Need for Federal Control of the High-Grade Evil," by William E. Colby, was read. Mr. Colby was unable to be present, but the statement which he had prepared concisely summed up the difficulties in controlling high grading by the States and the need for Federal control.

Walter Stalder, Consulting Petroleum Geologist of San Francisco and Vice Chairman of the Mineral Research Committee, discussed the "Coordination of Agencies in Mineral Research." He pointed out the large number of agencies in the State that were working along overlapping lines and the results that had already been attained by the mineral committee in coordinating the work of these agencies.

The announced subject for an address by Frank H. Probert, Dean, College of Mining, University of California, was "National Publicity on the Mining Industry," but he chose to give it the subject "Our Job." In a masterly way he showed that it was "Our Job"—that is, the "Job" of the mining profession—to make the public fully conversant with the part that the mining industry plays in every phase of our life.

Leon Starmont, Secretary

The papers presented at the California Development Session will be published in a later issue of THE MINING CONGRESS JOURNAL.

ECONOMIC AND LEGISLATIVE QUESTIONS

The concluding session of the meeting on Thursday morning, given over to a discussion of economic and legislative problems of the industry, was presided over by Robert E. Tally, General Manager, United Verde Copper Company. There were no prepared papers for this session, and the meeting was open for discussion from the floor under the five-minute rule. So intense was the interest that no heed was given to the usual time for adjournment.

George H. Bailey, of the staff of the American Mining Congress, gave a review of the problems of Federal taxation of mines. He outlined the present situation in regard to depletion as it is now being studied, through the efforts of the American Mining Congress, by the Congressional joint committee and the Bureau of Internal Revenue.

The problem of State and local taxation was discussed by T. H. O'Brien, General Manager, Inspiration Consolidated Copper Company; Axel P. Ramstedt, Vice President, Tamorack & Custer Consolidated Mining Company; and A. G. Mackenzie, Secretary of the Utah Chapter of the American Mining Congress.

The local tax problem was summarized by Mr. O'Brien by saying that his company paid 51 percent of the taxes of the county. In a local school district the company paid 98½ percent of the school taxes. Yet when an attempt was made to question the manner in which bids for a new school building were offered, the cry immediately went up that the mining company was trying to dictate policies and run the schools.

Mr. Vandergrift, Director of Research of the California Taxpayers' Association, expressed the opinion that the remedy for excessive taxation lay in careful analysis of all public expenditures so as to get full value out of the tax dollar. To this end it is necessary that the taxpayer shall know how the money he pays in taxes is expended, and this is a matter of accurate checking and efficiency in administration.

Dean F. H. Probert made an eloquent plea for simplicity in legal language. He referred to the income tax law, with its ambiguity of phraseology. He said in part, "The English language is an acceptable vehicle for the exchange of thought. I ask that our legislators see to it that our statutes are written in that language so as to be understandable to the common people of the country."

J. F. Callbreath made a clear and forceful statement of the Tariff Problem as it affects the mining industry. He outlined the work of the Mining Congress with respect to the tariff. He said the Mining Congress, as it represents the mining industry, demands that raw materials be given the same measure of protection as manufactured products.

Robert E. Tally discussed stabilization of the mining industry. He defined stabilization as a common-sense adjustment of supply to demand which would mean uniformity of production, steady operation and continuous employment for labor. He said, "Stabilization, as we view it, is the adjustment of supply to demand at prices that will make the industry attractive, not only from the standpoint of fair returns on the investment but with sufficient profits in addition to allow something for research and the search for new properties."

Mr. Callbreath outlined the policy of

the American Mining Congress with respect to the so-called "Blue Sky Laws." He said that "the American Mining Congress fully approves every possible effort to prevent fraud and to protect investors who are not able to know how their investments shall be made, but we emphatically insist that it is the privilege of an American citizen to put his money in any enterprise which is a substantial gamble at the beginning in order that our undeveloped resources may be made accessible and be made available for the uses of industry."

J. O. A. Carper supplemented the remarks of Mr. Callbreath and advocated the abolition of blue sky laws.

The report of the Committee on Resolutions was presented by Milnor Roberts, chairman of that committee. The Committee on Resolutions, made up of one representative from each State, consisted of the following: Arizona, W. V. De Camp; California, C. W. Merrill; Colorado, J. G. Clark; Idaho, Axel P. Ramstedt; Montana, C. R. Berrien; New Mexico, J. F. Woodbury; Oregon, A. W. Strowger; Utah, Ernest Gayford; Washington, Milnor Roberts; Oklahoma, J. D. Conover.

The following resolutions were recommended for passage by the Resolutions Committee and approved by the Congress.

Resolution No. 1

Whereas, geophysical prospecting methods have become of considerable importance in attempts at discovery and location of mineral bodies; and

Whereas, future advance in the geophysical sciences, particularly with respect to location of hidden ore bodies make it of increasing importance and thereby require adjustment of existing Federal mining laws:

Now, THEREFORE BE IT RESOLVED, by the Western Division of the American Mining Congress, assembled at Los Angeles, Calif., September 10 to 13, 1928, that a committee be appointed by the American Mining Congress to investigate and compile, in so far as possible, facts covering the progress made in this science to date, and that this committee submit to the American Mining Congress at the earliest time possible a report recommending what changes, if any, they consider advisable in our Federal mining laws to give proper encouragement to the development of this promising science.

Resolution No. 2

Whereas, the practice of "high-grading" is now prevalent in a number of mineral-producing States; and

Whereas, the operators of gold and other mines are being robbed of many thousands of dollars annually by "high-graders"; and

Whereas, a proposed Federal "high-grade" act has been prepared, and legislation of this nature is desirable and necessary to protect the operators of such mines:

Now, THEREFORE, BE IT RESOLVED, that the Western Division of the American Mining Congress, assembled at its annual convention in the city of Los Angeles, on this 13th day of September, 1928, endorse the principles involved in the proposed act, and authorize its officials to provide for the introduction of an act embodying these principles at the next session of Congress, which convenes on December 3, 1928.

Resolution No. 4

Withdrawal of Public Lands from National Forests

Whereas, following the recent passage by Congress of a bill withdrawing lands in the Angeles National Forest from entry by mineral location, in order to preserve them for recreational purposes, it is proposed by certain interests or groups to ask for similar withdrawals in others of the National Forests in California; and

Whereas, there are potential mineral resources in some of these areas:

Now, THEREFORE, BE IT RESOLVED, That the Western Division of the American Mining Congress go on record as being against withdrawals of National Forest areas from mineral locations until the proposed lands have been classified for mineral possibilities by a competent governmental agency; and

BE IT FURTHER RESOLVED, That provision be made for restoration to mineral entry of any withdrawn lands that may be subsequently found mineral bearing, such as would justify their inclusion as mineral land, and having also due regard for protection of domestic water supply and flood control.

Resolution No. 5

Whereas, it is of the utmost importance that the present prosperity, security and welfare of these United States be preserved and maintained; and

Whereas, we face in the coming decades the keenest of foreign competition, together with changes in the employment situation within our borders, due to the mechanization of existing industries; and

Whereas, that nation which maintains the best balanced program for the development of new industries will maintain supremacy as regards the welfare of its people:

Now, THEREFORE, BE IT RESOLVED, That the Western Division of the American Mining Congress, assembled at Los Angeles, Calif., September 10 to 13, 1928, urge upon our governmental administrations, State and National, that increasing effort and increasing funds be devoted:

(1) To the development of new mineral resources at present hidden; and

(2) To invention and to the creation of new industries for the utilization of the raw mineral material so developed.

To this end we urge that funds be allotted in more reasonable proportion to the importance of such development as compared to our total appropriations for industries already developed, and we particularly urge increased appropriation for Federal and State Bureaus of Mines and geological surveys and such other agencies as foster the development of the mining industry.

Resolution No. 6

RESOLVED, That the thanks of the Convention are hereby extended to the Convention Committees, to the Press, and to the People of Los Angeles, to the authors of the many excellent papers which have been presented. and particularly to the Los Angeles Biltmore Hotel for the excellent accommodations and many courtesies which have been extended.

Resolution No. 3 was as follows:

This resolution, No. 3, affects pending Federal legislation affecting mineral development in California, and has to do with withdrawal in connection with public lands and the rights to the minerals in them, and on this resolution the committee wishes to report, as follows:

Pending Federal legislation affecting mineral development in California,

Whereas, there has been introduced in the National Congress a bill (H. R. 404) to repeal that part of the Stock Raising Homestead Act, which reserves to the Government the coal and other minerals in the land, and also H. R. 353, to allow World War Veterans to have title to coal and minerals in their stock-raising homestead and land entries; and

Whereas, the areas of public domain in the Western States open to mineral prospecting are gradually diminishing:

Now, THEREFORE, BE IT RESOLVED, That the American Mining Congress investigate and give consideration to the above noted bills with a view to protecting the interests of the prospector and permitting utilization of mineral deposits that may be found on such lands.

(This was tabled because of differences of opinion expressed by representatives from the different states.)

On Monday noon the visitors were entertained at a complimentary luncheon at the Hotel Biltmore. Edwin Higgins, managing director of the Los Angeles Chamber of Mines and Oils, acted as toastmaster, and the "victims" responding were Rolla King, Philip Wiseman, C. W. Merrill, R. R. Boyd, W. W. Bradley, George Otis Smith, F. H. Probert, George A. Packard, H. S. Mackay, E. P. Mathewson, Dorsey Lyon, John E. Hodge, Calcock Jones, Robert E. Tally, F. W. MacLennan, C. W. Knights, John D. Joyce, and Mrs. Horace V. Winchell.

Entertainment for visiting ladies included a motor trip through Los Angeles and surrounding communities, with luncheon at Madame Helen's in Hollywood and a reception and tea at the home of Mrs. Philip Wiseman.

At a meeting of the board Frank M. Smith, Bunker Hill & Sullivan Mining Co., was unanimously elected chairman of the Board of Governors, and Leon Starmont was elected secretary for the year 1929. Spokane, Wash., was selected for the 1929 meeting.

The whole convention was a great success. The attendance was large and all sessions were well attended in spite of the numerous competing attractions. The papers presented were clearly the result of much thought and effort. They commanded close attention and brought out much valuable discussion.

©Harold Gray

In Rock Creek Park

"There is something in October sets the gypsy blood astir"

MANGANESE PRODUCERS' CONVENTION

Increased Appropriations by Congress Recommended for Studies of Ore and Its Treatment—Cooperation of Steel Industry and Railroads Invited—Mining Practices Recommended.

MEETING in Washington on September 10 and 11, the American Manganese Producers' Association, which was organized a year ago, recommended the cooperation of Congress, railroads and the steel industry in developing the manganese resources of the country in order to make the United States independent of foreign sources of this mineral, which is essential in the manufacture of steel and other articles and for military uses. It was stated that railroads would reap an annual freight revenue of $5,000,000 from a properly developed manganese industry and that military authorities would be relieved of anxiety over adequate supplies of manganese. Congress was asked to aid in stimulating development of the industry through more adequate appropriations for studies by Government agencies of manganese areas and the production of the finished product for military and industrial uses. Speakers referred to sources of supplies of manganese in various sections of the country.

Following statements by a representative of the War Department as to the lack in the United States of adequately developed manganese and other essential war minerals, the association adopted a resolution requesting the Budget Bureau and Congress to provide additional funds to enable the Geological Survey and Bureau of Mines to conduct studies as to the occurrence, beneficiation, utilization, and economics of domestic manganese-bearing ores.

The association reelected J. Carson Adkerson, consulting engineer of Woodstock, Va., and Washington, D. C., as president, together with the following other officers: J. H. Cole, Domestic Manganese Development Company, Anaconda, Mont., vice president; A. J. Seligman, Butte Copper and Zinc Company, New York, treasurer; and H. A. Pumpelly, Domestic Manganese Development Company, Owego, N. Y., secretary. New directors elected were C. D. Hutchens, Manganese Ore Company, Watuaga Valley, Tenn.; Ottomar Stange, of the Stange Construction Company, New York; W. R. Spencer, Luna Manganese Company, Jackson, Mich.; W. J. Staunton, Cuban American Manganese Corporation, New York; Herbert Wilson Smith, Union Carbide Company, New York; R. H. Brown, of the Manhattan Electrical Supply Company of New York, was elected chairman of the board of directors, and an executive committee was named consisting of Messrs. Adkerson, Pumpelly, Seligman, and Brown, and D. H. McCloskey, of the Brown Manganese Mining Company, of Staunton, Va.

The association held two sessions daily and also a dinner, at which the toastmaster was Herbert Wilson Smith, who was formerly connected with the American Mining Congress. The chairmen of the convention sessions were mining men, including Francis E. Sinn, of the New Jersey Zinc Company; Robert Dwyer, of the Anaconda Copper Mining Company; and Mr. Seligman.

Mr. Adkerson stated in his annual report that there are hundreds of millions of tons of low-grade manganese ore available in Massachusetts, New Jersey, Minnesota, Colorado, Montana, Washington, California, New Mexico, Arizona, Nevada, Arkansas, Alabama, Georgia, Tennessee, and Virginia, and referred to methods which are being developed to treat them.

Course of the Industry

Tracing the recent course of the manganese industry, Mr. Adkerson stated that it "was born during the World War, cast aside as an orphan during the post-war period, and was finally adopted and redeemed by the manganese producers and property owners themselves, and with the strong arms of their combined support its feet have been planted on a firm foundation, and today it takes its place as a growing industry among the basic industries of the United States."

Mr. Adkerson stated that reports of the threatened deluge of foreign ores to the United States "has been the sword of Damocles over the head of the American producers and has served to retard development of American deposits until American industry had become resigned to the belief that there was little, if any, manganese in the United States." He called attention to the instability of the manganese situation in Russia, referring to the fact that American interests have withdrawn from that field, their concessions having been returned to the Russian Government. He stated that no developments in manganese are being had or contemplated in Australia and Africa.

Citing manganese developments in the United States, Mr. Adkerson said that operators who are investing hundreds of thousands of dollars in developing manganese reserves in this country "are accomplishing far more for preparedness and national security than those who cry that we have no manganese and can not develop an industry at home." He said there is a wide field of opportunity for further improvements in the development of low-grade manganese ore reserves in this country.

Progress in developing new methods of beneficiating manganese ore was reported by Mr. Adkerson. "Foremost among these," he said, "are the roasting of Rhodochrosite ores of Montana; the development of the Bradley process, which is based on leaching with sulphate of ammonia; the work of the Bureau of Mines station at the University of Minneapolis in manufacturing ferromanganese from manganiferous iron ore; the sulphur dioxide processes; magnetic separation; and sintering manganese ore both to raise the metallic manganese content and to make the material into a form suitable for the steel furnaces."

He compared the development of the manganese industry to the progress which had been made in the copper, zinc, and gold mining industries. "Thirty years ago the copper industry bemoaned the fact that it had but small reserves of high-grade copper," said Mr. Adkerson. "Today through the medium of low-grade ores the United States leads the world in the production of copper. Better mining and metallurgy, combined with large-scale operations, have many times multiplied our resources of non-ferrous metals. Mining companies are going back to their old tailing dumps and slag piles and are recovering values which less than a decade ago were not known to exist."

Continuing his comparison of other lines of mining, Mr. Adkerson stated that in Alaska gold ores are mined and milled for 67 cents a ton. The Utah Copper Company mines and mills its ore at a cost of 92 cents per ton. In the Wisconsin zinc fields ore containing 1½ percent zinc is being milled at a satisfactory profit when the raw ore carries a value of only $2 a ton. In the Joplin area of southwest Missouri ores are being mined when they carry values of from only $2 to $3 a ton. Ferromanganese is the product of the manganese industry which

corresponds to ingot copper, slab zinc, or pig lead. The average grade of ferromanganese is about 79 cents and its price of $105 per ton means that the manganese content is worth approximately 6 cents per pound, or practically the same price as slab zinc.

"The manganese industry must take its lesson from other lines of mining," said Mr. Adkerson. "It must not accept the economics of the iron mining industry. Iron ore is worth from $1.50 to $3 per ton at the mines. Manganese ore may be worth 10 to 20 times as much. Instead of copying iron ore mining practice, the manganese industry should turn to the zinc industry for inspiration."

Mr. Adkerson pointed out that the specific gravities of the principal manganese minerals are almost identical with that of the zinc blends, while the value of the manganese product is almost identical with that of zinc metal. Zinc operators mine and treat at a profit ore which runs 1½ percent zinc, while the manganese industry has been ignoring or discarding as tailings material running from 10 to 30 percent metallic manganese. "A ton of manganese ore running 15 percent manganese contains 336 pounds of metallic manganese," he added. "If we could recover it all and sell it for steel purposes as ferromanganese it would, at present prices, carry a value of $20.16 per ton. Even at the price the ferro-alloy makers are paying for foreign ore, the potential value of a ton of crude manganese ore running 15 percent metallic manganese would, at the mine, be from $5 to $8 per ton. This value for crude ore at the mine, when it runs only 15 percent metallic manganese, compares favorably with ores of other metals which are being mined at a profit when the crude ores carry values of only from $2 to $3 per ton. This is based on 15 percent metallic manganese ore when we have enormous tonnages of material running from 25 to 30 percent metallic manganese, which means that they carry values in manganese metal from $33 to $40 per ton."

Steel and Railroad Aid

Mr. Adkerson asked for cooperation of the steel industry in developing the manganese industry. In asking cooperation by railroads, through a survey of manganese resources on their lines and establishment of favorable freight rates, Mr. Adkerson said development of the industry would mean a freight revenue of $5,000,000 per year.

Maj. A. H. Hobley, of the War Department, said that while the United States is well supplied with some raw materials, it has insufficient quantities of manganese, antimony, chromium, platinum, tungsten, nitrates, quicksilver, nickel and tin. He stated that the most satisfactory method of securing necessary supplies of these materials is by domestic production, failing which substitutes must be developed. Referring to studies by the department of possible supplies of these materials in an emergency, Major Hobley cited the development of substitutes, such as an alloy of barium and calcium with lead to replace antimonial lead; tungsten to replace platinum in electrical needs; manganese molybdenum for tungsten in tool steel; and a similar steel for nickel steel for gun forgings.

In outlining types of manganese ore deposits in Virginia, Prof. J. S. Grasty, of Charlottesville, predicted prosperity for the industry. Professor Grasty stated that there are two leading types of manganese ore deposits in Virginia. One deposit had yielded 200,000 tons of ore under production by the Carnegie Crimora Mining Company. The Hy-Grade Manganese Company had developed a tonnage of positive ore at the Mineral Ridge mine. Professor Grasty stated that from one tract of 8 acres on the west of the Blue Ridge Mountains manganese ore valued at $8,000,000 has been produced and sold. He believed that thousands of other acres to the northeast and southwest would yield manganese. Resources were also said to exist 8 miles northeast of Waynesboro, Va. Manganese ore is also found on Red Mountain, between Staunton and Lexington. Ore resources in the Allegheny Mountains were also referred to. The Hy-Grade Manganese Company has been producing ore averaging 46 percent metallic manganese and 6 percent metallic iron. "In Virginia the tonnage of proven ore is large and the potential ore may prove to be vast," said Professor Grasty.

Iron Ore Resources

Dwindling supplies of iron ores in the Lake Superior district was referred to by L. B. Miller, of Cleveland. He said: "Among metallic ores there is a conspicuous example of one that, for the present, is being mined in usable condition, as it is severed from place; namely, iron ore. In Lake Superior and Alabama these ores are now being freely used in natural state, but while total oxides of iron in both districts are enormous, the tonnage of high-grade ore is limited, and a warning has already been sounded by Dr. Hotchkiss, of Michigan, to the effect that careful study of methods for beneficiation of low-grade iron ores in the Lake Superior district is not only desirable but imperative, in order to provide supplies for the not distant future."

Mr. Miller stated that manganese is not alone in having a shortage of high-grade ores, as copper, gold, lead, zinc, silver and other metals are obtained from low-grade deposits. He stated that Arkansas contains a moderate tonnage of high grade and an enormous amount of low-grade manganese ore, and referred to experimental work along this line conducted by W. G. Rinehart, of Batesville. Reference was made by Mr. Miller to processes of transforming low-grade ores into high-grade types, including the roasting process at Butte, Mont.; the smelting process at the Minneapolis station of the Bureau of Mines; and the leaching process developed by Wilson Bradley, of Deerwood, Minn.

Drs. Oswald Schreiner and J. J. Skinner, of the Department of Agriculture, spoke of the use of manganese in fertilizer, and T. L. Joseph, of the Bureau of Mines, reviewed the work of its Minneapolis station in the treatment of manganiferous iron ores.

Reasons why development of the American manganese industry should be fostered were advanced by A. H. Hubble, of the Engineering and Mining Journal of New York.

Reports on manganese production were made by delegates from Montana, Georgia, Minnesota, New Mexico, Tennessee, and Washington.

The manganese industry of Cuba was discussed by Armando Roa, acting commercial attache of the Cuban Embassy. He stated that development of the industry during the war resulted in the investment by Americans of $35,000,000 in the Cuban mining industry. "The same impetus which this industry had during the war could be given in time of peace, for this mineral is required for industrial purposes in certain chemicals, the steel industry, and for dry-cell batteries in the electrical industry," he said.

RE-TREATMENT OF TAILINGS

A description of various cyanide methods for the retreatment of tailings from the famous Comstock Lode, Nevada, are given in Serial 2883, recently issued by the Bureau of Mines. In the earliest days the amalgamation process was accepted as the principal method for the recovery of the precious metals from the Comstock ores. The large tonnage of good-grade ore from the Comstock Lode attracted the best metallurgical talent of the time, and developed there the highest skill in the art of amalgamation, including the auxiliary chemical preparation of the ores and the mechanical operation.

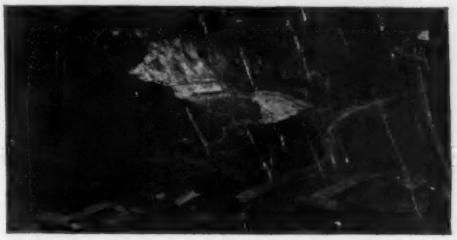
The present study by the Bureau of Mines deals with large accumulations of the lighter and better grade of tailings, impounded on the banks of the Carson River and which are known as "Douglas tailings."

Copies of Serial 2883, "The Retreatment of Comstock Tailings," by E. S. Leaver and J. A. Woolf, may be obtained from the United States Bureau of Mines, Washington, D. C.

METALS

GUY N. BJORGE
Editor

Practical Operating Problems of the Metal Mining Industry



The USE *of* SCRAPERS *in* UNDERGROUND LOADING *at the* RUTH MINE

By C. F. STEINBACH*

SLUSHING was first used in the Ruth mine of the Nevada Consolidated Copper Company, at Ruth, Nev., in the latter part of 1920. The first attempt at slushing was made with a road-type scraper, with an I-H single drum Ingersoll-Rand tugger mounted on a regular machine column. This was used in filling square sets with waste and would best be described as back-filling of the stopes in ore bodies mined by the square set method in the Ruth mine. The advantage of this single unit was immediately recognized, as only two men

SCRAPERS

in entry driving economical up to 150 ft. Used in tandem up to 400 ft. Many opportunities for slushing. Slushing superior to hand scramming of muck, both for cost and versatility.

were required—one to operate the tugger and the other to load, dump, and pull back the empty scraper—in comparison with eight men with wheelbarrows and shovels in the former method of stope filling. The success of this improvised method created an incentive to eliminate the lost time and physical exertion necessary to pull back the empty scraper. With this in view, two I-H Ingersoll-Rand tuggers were mounted on a single column, placed vertically, so that one could be used as a pull-back tugger. This arrangement proved to be a disadvantage for two reasons, viz:

(1) Considerable ground movement loosened the set-up; and

(2) The excessive weight to be handled when moving the cumbersome unit from place to place by hand as necessity required.

To obviate this, the two tuggers were mounted on a wooden base made up of two 6 x 12's, 5 ft. long and bolted together. One of the tuggers was bolted directly to the wooden platform, while the other was placed on a 12 x 12 block

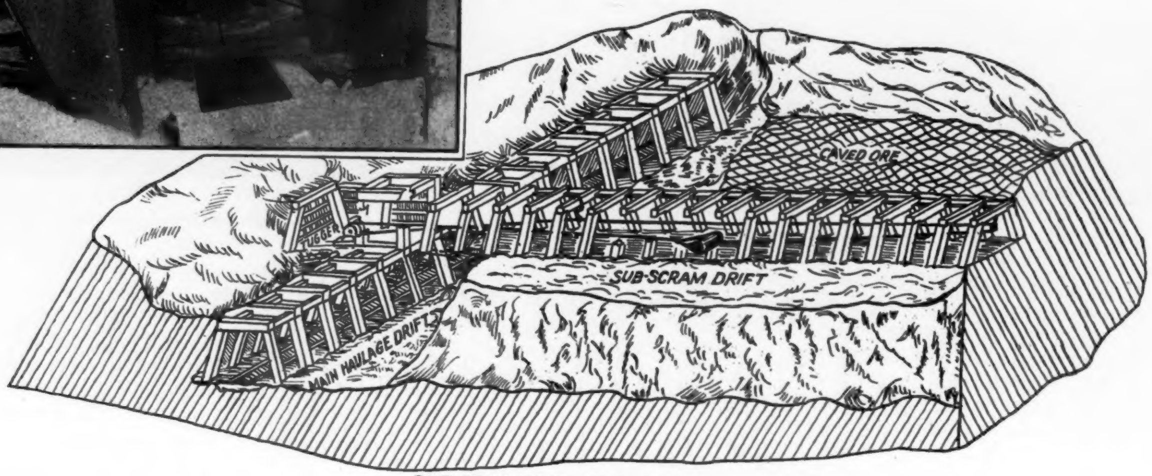
* General mine foreman, Nevada Consolidated Copper Co., Ruth, Nev.

Tugger in position for pulling from around head frame

Profile of old waste fill produced with scraper. From head frame to end of pile is about 200 feet

Hoe type scraper moving waste from head frame

Photograph showing a composite view of tugger, grizzles, scraper and tugger-man operating as shown in the diagram below



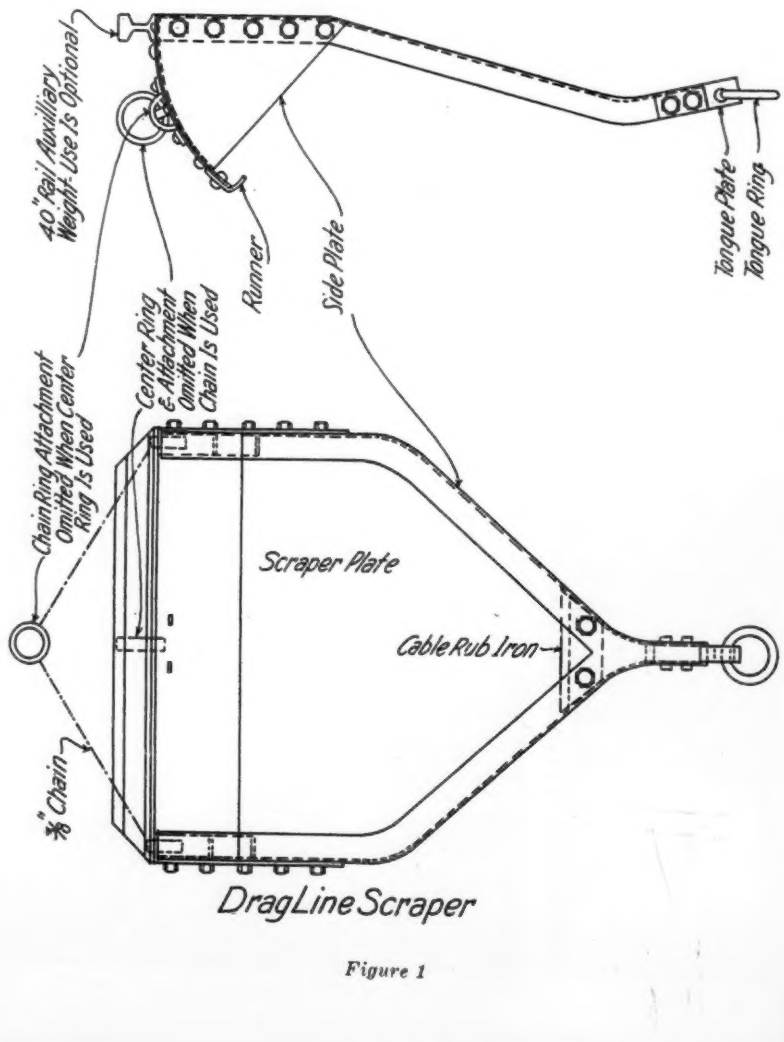
SKELETON VIEW OF SUB-SCRAM METHOD

Figure 4

behind and above the other, thus permitting the rope of the one to run over the top of the other or first tugger. The throttle of one tugger was connected to the clutch lever of the other, so that when air was applied it would release the clutch of the other and permit one rope to run free at all times. Heavy iron rings were placed on the ends of the wooden platform in order to move the unit from place to place with the aid of a snatch-block and cables with the tuggers' own power. This unit was used for scraping ore for the first time in the square set stopes, replacing considerable hand mucking—two men with the unit handling more ore than eight men with shovels.

About this time efforts were made to find a more suitable scraper to replace the road type, with its manual loading and dumping. After considerable research and many trials the hoe-type scraper, as shown on the accompanying drawing, was developed. This was patterned after the Lake Superior hoe type, which eliminated the man to load and dump it, and this type is still in general use throughout the district. (See Figure 1.)

After observing the gratifying results obtained with the scraper when used either in mucking ore or waste filling, four Sullivan Turbinair double-drum machines were placed in use, followed shortly thereafter with four Waugh Turbinair machines of the 300 type, and two Ingersoll-Rand 6-H double-drum tuggers. All of these machines went into use within six months of the arrival of the first one, so it is obvious that slush-



DragLine Scraper

Figure 1

ing was used in manifold applications. Two Ingersoll-Rand 6-HA's were soon added to the complement of tuggers as additional and advantageous applications were found. Each model was mounted on a wooden base made up of three 6 x 12's bolted together, with an iron ring in each end for handling. The bases were later reinforced with a half-inch steel plate on each side to keep the bolts holding the tugger from pulling through or wearing through the wood, due to the great stress and vibration set up when pulling. These bases have been standardized in the Ruth mine.

Of the different types of machines used, the turbinairs were the fastest, but due to their exceedingly high speed, wear and tear on them were excessive, causing frequent changes and delays, and thus offsetting the advantage of high speed. For steady and consistent pulling, the piston machines performed the most successfully, and satisfactorily withstood the abuse inherent to underground conditions.

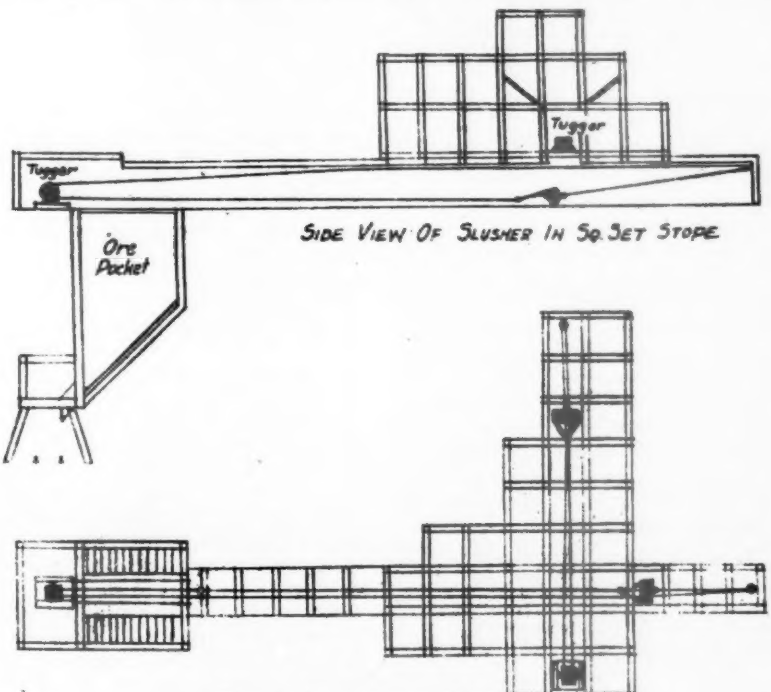
Slushing is used in the Ruth wherever and whenever its application is at all practicable and feasible. In and around a big mine the opportunities are many. Details of some of them follow.

Figures 2 and 3 illustrate the schemes used in mining small bodies of high-grade ore. Square sets were placed three wide—the center set being used as a runway for the scraper. Slides were placed in the two outside sets to transfer the broken material to the runway, through which it was pulled with a scraper to the ore pass, and from there loaded into the mine cars. Filling the stopes was very successfully accomplished by driving a raise to the level above, filling it with waste from this level, drawing the waste at the convenient floor in the stope, and distributing it with scrapers. In a thin, flat ore body, cross-scraping with one or more scrapers is very satisfactory. (See Figure 3.) In one flat ore body not over two floors high, and of a large plan area, two men with scrapers handled a production of 60 tons daily.

Complete unit, except snatch-block. Tugger just in front of trees with about 300 ft. of pull-cable out

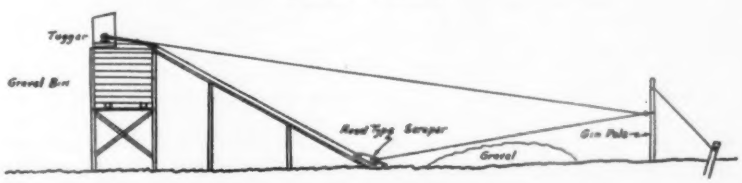
Scrapers are used in lieu of cars in driving main haulageways away from pockets at stations and in driving sub-level drifts from the tops of raises. Their application is very economical up to 150 ft. and may be used up to 200 ft. In the smaller drifts, where the timbers are not too large, these may be tied to the scraper and delivered to the face in this manner. By the use of two scrapers, in tandem, so to speak, distances up to 400 ft. of small drift have been readily handled. In this arrangement the first slusher is placed at the ore-pass and used up to its economical limit—about 200 ft. A second slusher is then installed on a platform 3 ft. above the bottom of the drift, leaving ample room for the scraper to slide underneath. A snatch-block is placed in the working face and one to the rear, so that muck may be pulled to within reach of the first slusher's scraper. In this case, the miner's helper operated the second slusher. In continuous operation a third man is necessary near the second slusher to keep the muck from piling up beyond the limit of the first slusher's scraper.

The mining system at the Ruth comprises a series of branch-raises, with finger raises at their tops, driven from the haulageways. The tops of the fingers are theoretically situated at the bottom of the ore. In places, however, ore is found below the finger tops and, at times, extends down nearly to the haulage level. Recovery of this ore is done by a method known here as "sub-scramming," illustrated in Figure 4. Small drifts are driven at right angles to the haulageway from the pony set, and at the elevation of the tops of the haulageway caps. Chutes are placed between the drift sets and the ore over the top of the drift caved. Slushing is used both in driving the drift and in transferring ore from it to the haulageway, where it is dumped directly to the cars. A very satisfactory ore recovery, both in cost and extraction, has been made in this



Plan Of Stope Showing Cross Scraping

Figures 2 and 3



Method Of Loading Trucks

Figure 5

manner. There follows some data on this procedure:

Average of 22 trains of 10 3½-ton cars each.

Average loading time—1 hr. 3 min. per train.

Number of scraper loads—72 per train.

Average tonnage per scraper load—0.48 ton.

Average distance of loaded scraper trip—68 ft.

In all, two men were employed in this process, one operating the motor on the haulage level for changing cars and one operating the scraper.

Data on driving sub-scram drifts are as follows:

Size of drift—7 ft. 6 in. x 9 ft. 6 in.

Average tonnage per 5-ft. round—33 tons.

Average time of cleaning out round—2 hrs. 30 min.

Average number of scraper loads—117.

Average time per scraper load—1 min. 17 sec.

Average distance per scraper trip—60 ft.

Average load per trip—0.28 ton.

The crew consists of one miner and one helper. These two men do the drilling, blasting, mucking and timbering in the face, and switch the cars in the motor drift, as required.

In driving a haulageway away from the shaft pockets, the following data may be of interest. (These data apply to 30 ft. of haulageway):

Size of drift—10 ft. 6 in. x 10 ft.

Average distance scraped—48 ft.

Average time cleaning out round—3 hrs. 4 min.

Average number of scraper loads—134.

Average time per scraper trip—1 min. 22 sec.

Average load per scraper trip—0.36 ton.

Crew consists of three men.

Slushers also have many useful applications on the surface, and both electric and air-driven machines have been used. Figure 5 illustrates a gravel bin for loading trucks. Gravel is dumped on the ground in front of the slide and is in turn pulled to the top of the bin by means of a scraper mounted there.

At the Queen, one of the small development shafts, waste is dumped close to the head frame through a slide situated in it and scraped out to the dump with a slusher. (See illustrations.)

As a matter of interest, the ropes and snatch-blocks used are a very important and essential part in slushing operations. Many types of snatch-blocks were tried out at the Ruth, including one developed in the company's shops, but all gave difficulty, either by permitting the cable to bind between the sheave and the side of the block or burning the axle and bearings. A block with a roller bearing for its outstanding feature, and with an overlapping side, was finally secured from the Skookum Company of Portland, Oreg. Its original cost is considerably higher than the ordinary block but it is well worth the money, both from a standpoint of continuous operation and wear on the cables. Three-eighths inch and 5/16-inch standard plow steel hoisting cables are used.

In conclusion, it may be stated that slushing is a decided improvement over the old methods of handling muck, both from a standpoint of costs and versatility. It may be applied to advantage in nearly all cases where hand tramming would formerly be used, up to the distances mentioned and under the conditions stated.

RECENT DEVELOPMENTS IN MINING INDUSTRY

(*Continued from page* 752)

Another important change is the development of methods for recovering gasoline from natural gas. The first commercial plants to recover gasoline from this source were built about 1910. In 1911, 7½ million gallons of gasoline were thus produced, whereas in 1927 this had increased to well over 1½ billion gallons, or 12 percent of the total gasoline production for that year. This extremely volatile product is especially valuable for blending with heavier gasoline and naphtha for the manufacture of motor fuel, thus making usable large quantities of the heavier products, which could not have been used in automotive engines without the addition of this lighter ingredient.

Rotary drilling was first used in 1896, in Texas, and this method made possible the penetration of caving formations which could not have been drilled with cable tools, and thus enabled the drillers to develop important oil fields on the Gulf Coast and in California. Prolific deep sands, far below the surface and overlain with strata not standing well enough for cable-tool equipment, can now be reached with the rotary drill. This development has thus added largely to our supply of crude oil.

The last improvement in petroleum technology I will mention is the development of methods for increasing the recovery from oil-sands. This innovation only dated back to 1903, when gas under pressure was forced into an oil well, and, after the pressure was released, it was found that the productivity of the well had been materially increased. As a result, older fields in Pennsylvania, West Virginia, Ohio, and Oklahoma are today being re-pressured with gas or air, and marked increases in production are thus effected.

I cannot leave the subject of recent progress in the mining industry without touching briefly on the safety movement which is receiving so much attention from thoughtful men. Since the beginning of this century, permissible explosives have come into use in coal mines, and today about one-third of our coal is produced by them. The recognition of the explosibility of coal-dust and the introduction of rock-dusting in bituminous coal mines mark another great stride toward safety. The introduction of permissible electric equipment is an important step in coal mining, although as yet only about one-third of our equipment is of permissible character. The wide use of the electric cap-lamp has come within our era, and electric blasting is another important safety feature. The use of water on cutter-bars, steel-housed ventilating fans, and other devices, are significant changes. The spread of workman's compensation acts has hastened the advance of safety measures in both coal and metal mines.

Within the period under review, safety and health conditions in metal mines have generally improved. Ventilation is given more attention; dust problems are dealt with by wet drilling and other practices. The use of low-freezing explosives is a step in the right direction, and the practice of blasting only at the end of the shift is a comparatively new development. Concrete, cement mixtures and structural steel underground have increased safety; multiplying the number of exits has diminished fatalities; better trolley-wire protection and the improved use of electricity generally, have assisted in bringing about safer conditions.

Many and various as are the subjects I have touched upon to indicate progress in the mining industry within less than one-third of a century, yet the list as I have given it is incomplete; however, even this rough outline shows the astonishing changes that have come within the professional lives of many of us, and it may serve to suggest to the young engineers and undergraduates here the progress that may be expected in the next three decades. No one doubts that changes in a given period of time to come will be greater and more important that in an equal time that has passed.

WHY NOT
an ELECTROLYTIC ZINC PLANT
in the SOUTHWEST*

By J. B. TENNEY †

Development Of Complex Ores In Southwestern Part Of Rocky Mountain States Has Been Retarded By Prohibitive Distance To Zinc Treatment Plants—A Discussion Of The Factors Entering Into The Establishing Of Plants In This District

IN the Southwestern part of the Rocky Mountains the development of complex ores has been retarded by the prohibitive distance to the nearest suitable zinc treatment plants. In the northwestern and central Rocky Mountains the building in the past 10 years of electrolytic zinc plants at Anaconda, Great Falls, Trail, and Burke has tremendously stimulated the mining and exploiting of this common type of ore, with attendant greatly increased production of lead, zinc, copper, gold, and silver.

The requirements of selective flotation allow for the making of high-grade lead, copper, and zinc concentrates. If the zinc concentrates could be made free from valuable impurities such as lead, copper, gold, and silver, they could be economically shipped to mid-western retort plants designed for this type of zinc concentrate. Unfortunately, a very considerable proportion of the precious metal content of the western ores accompanies the zinc blends. Although some of this is saved in retort residues, the treatment cost is thereby increased so materially and the proportion saved so small, that concentrates of ordinary grade cannot stand treatment charges and freight.

In weighing the chances of the success of a plant requiring the large outlay of money necessary for an electrolytic zinc plant, the amount of ore available and the life of the deposits are vital considerations. In this article an attempt will be made to show that there are enough important deposits in the Southwest, including New Mexico, Arizona, Southern California, and Northwestern Mexico to assure the success of a plant up to a daily capacity of 200 tons of metallic zinc. There are three deposits fully developed and equipped, one in New Mexico, one in Arizona, and one in Southern California, capable of shipping about 215 tons of 50+ percent zinc concentrates a day. Several other deposits are now developing capable of shipping at least a like amount, and a greater number of others lying idle. In the developed properties a long life is assured, at least 10 years at the present rate of production. Those developing and those lying dormant occur for the most part either as strong veins cutting pre-Cambrian country rock of uniform character, or as replacements of limestone. The probability of a long life is good for either type. With normal metal markets, a substantial profit could be made for at least 10 years if a zinc plant suitable to the type of concentrates yielded by them were built in the Southwest.

In considering the location of an electrolytic zinc plant, the most important factor is cheap power. Due to the high freight rates into the mountain States, and their lack of petroleum and coal resources (except in the north of New Mexico), any plant built there would have to be near an available source of water power. A plant central to the largest available tonnage would be in the mountains of Arizona or New Mexico. All water power so far developed is contracted for, so that a large outlay in water-power development would be a necessary adjunct of a plant built there.

A second alternative in location would be near Los Angeles, using petroleum or natural gas as a source of power. The freight on concentrates would be higher than to a plant more centrally located, but as the concentrates would be high grade, and as the zinc produced would have to stand the freight either east or west to consumers, the tariff on metallic zinc would not be materially higher, assuming equal power costs, for a plant at seaboard than for a centrally located one. It is necessary that power cost not more than six-tenths of a cent per kilowatt-hour to compete with retort plants.

The zinc produced by western ores is essentially a by-product. For most of the deposits it is more important to realize on the lead, gold, silver, and copper in the ore than on the zinc. The chief advantage of the electrolytic zinc plant is that high extraction of these important constituents of the ores is made possible. Thereby the high zinc penalties made necessary at copper and lead smelters in order to realize on the full gold and silver content, if the zinc is not separated, is obviated; and the large loss of the gold, silver, copper, and lead is avoided if zinc concentrates are made.

Complex Ore Deposits

Arizona Deposits

In Arizona there are two types of complex ores. In the one the ore is made up of mixtures of zinc blende (usually blackjack), galena, and pyrite, in silicious gangues, with generally high gold and silver content. Work done on them has shown that from a quarter to a half the gold and silver accompanies the blende. In the other type the ores are mixtures of chalcopyrite, zinc blende (blackjack), and pyrite in siliceous gangues, with lower precious metal content. One of the larger of these deposits is now being exhaustively studied. Not enough work has been done on them to determine with which major constituent the gold and silver is associated.

Mohave County.—During the abnormal zinc market of 1915, 1916, and 1917 two mines in the Cerbat Mountains north of Kingman were extensively developed, and made large shipments of zinc concentrates and crude zinc ore to mid-west retort plants. In these two mines the ore occurs as veins cutting pre-Cambrian schists and gneiss. The ore shoots are large, and were followed down over 1,400 feet without change in size or values. The minerals are silver- and gold-bearing blende and galena. Both properties are being reopened, and others in the same range are being developed with equal promise. During 1915, 1916, and 1917 the district produced, mostly from the two mines, 51,579,166 pounds of zinc. Zinc was first shipped from one of these deposits, the Golconda Mine, in 1908, and this mine produced, during a normal zinc market of about 5 cents a pound, 40,608,764 pounds from 1908 to 1914, inclusive. With the advances made since 1917 in selective flotation, and given an electrolytic zinc plant in the Southwest, the Cerbat Mountain Mines should produce at least what they did in 1915, 1916

* Presented to joint meeting, Western Division, American Mining Congress and A. I. M. E., Los Angeles, September 10, 1928.

† Arizona Bureau of Mines.

and 1917, or an average of 17,000,000 pounds a year, equivalent to about 24 tons of metallic zinc daily.

Two small customs flotation plants were run in 1926 and 1927 during the high zinc market of those years, but the drop in the market and the high freight and heavy treatment charges, together with the small payments for high precious metal content from retort plants, forced suspension at the end of 1927. These plants demonstrated that most of the gold and a large proportion of the silver content of the ores accompany the zinc blende.

Santa Cruz County.—In this county in the southeastern part of the State, one large deposit, the Montana Mine, has been developed and equipped for production. The ore occurs as a large ore shoot in a vein cutting diorite. Before building a concentrator a year was spent developing underground, and by a diamond drill, and the ore shoot was followed down 1,200 feet on the dip, with no diminution in size or values. The ore is a mixture of gold- and silver-bearing blende, galena, pyrite, and a little chalcopyrite. A 300-ton selective flotation concentrator is completed, capable of turning out 44 tons of 50+ percent zinc concentrates daily, equivalent to about 20 tons of metallic zinc. About half the gold and silver accompanies the blende.

At Washington Camp, in the eastern part of the county, there are large deposits of high-grade complex zinc-copper-lead-silver-gold ore occurring as contact metamorphic limestone replacements. The deposits were extensively mined at shallow depths for oxidized copper ore in the '90's. Later they were acquired by the Westinghouse interests. Under their management an attempt was made to treat the ore by table concentration and magnetic separation of the iron from the blende. Experiments were conducted for many years, and in 1915 large-scale production started. Copper and lead concentrates were made and zinc tails piled up. Some of the zinc tails were cleaned and shipped. During 1915, 1916 and 1917, 3,544,860 pounds of zinc were produced. The less zincy parts of the deposits were worked, leaving large pillars and whole ore-bodies of more zincy ores untouched. The ore is probably amenable to selective flotation, so that, if the mines were reopened, a much greater production of zinc could be made. The ores are high grade and would undoubtedly be worked at a good profit if an electrolytic zinc plant were built in the Southwest. No great tonnage of ore is blocked out, but a substantial tonnage is indicated, as the mineralized area is a large one. The deposits have not been touched for 10 years except by lessees.

A number of other complex ore deposits occur in the Patagonia and Santa Rita Mountains which have not been developed sufficiently to demonstrate what tonnage could be expected from them. They occur as veins from which rich silver-lead ore was mined from the oxidized portions in the early days. A considerable tonnage would be developed if an electrolytic zinc plant were built in the Southwest.

Yavapai County.—In this county, in the Bradshaw Mountains, in the central part of the State, occur a great number of vein deposits from which gold ore was mined in the '90's and the early years of the present century. Most of them bottomed at shallow depths in low-grade complex ores. Some attempts have been made to treat them, notably at Crown King, during the early War years, but the attempts were not successful, due to the unsatisfactory condition of zinc concentrate disposal. Milling by the Bradshaw Reduction Company on ores from the Crown King, Wildflower, Tiger and other veins showed that a considerable proportion of the gold and silver accompanies the blende. The deposits are individually small, but in the aggregate would furnish a considerable tonnage of zinc concentrates if an electrolytic zinc plant were built in the Southwest. The veins cut pre-Cambrian schist and granite, and would probably continue to indefinite depths without change in size or tenor.

A very large deposit of low-grade zinc-copper ore is now being carefully studied in this county, and may be economically worked. If the experiments are successful, the deposit will produce a very considerable tonnage of zinc concentrates for a long period.

Cochise County.—The only large deposits in this county, which adjoins Santa Cruz County on the east, are in the Dragoon Mountains. They are contact metamorphic limestone replacements of medium-grade ore. In the largest deposit at Johnson Camp, a very considerable tonnage is blocked out of chalcopyrite-blende ore, with low gold and silver content. The ore is amenable to selective flotation, and a profit could be made if an electrolytic zinc plant were built in the Southwest. A probable life of at least 10 years on a basis of 10 to 12 tons daily of metallic zinc is indicated.

Pima County.—In the Sierrita Mountains south of Tucson occur several deposits of complex zinc-copper-lead ore. From one of them a considerable reserve of ore is reported developed, and during 1915, 1916 and 1917 a small tonnage of oxidized zinc ore was shipped from mine dumps and development work. The ore blocked out is said to be primary sulphide. The mine is now flooded.

Other deposits, one of which is being actively developed, show low-grade complex ore, which might be mined at a profit if an electrolytic zinc plant were built in the Southwest.

Pinal County.—Complex ore deposits occur in two localities in this county in the south-central part of the State. The largest developed deposit is in the Magma Copper Company mine at Superior, at the eastern end of the large copper oreshoot. About 20,000 tons of this type have been developed. None has been mined, and a much larger tonnage is probable. The ore is silver-bearing blende-galena-pyrite ore, amenable to selective flotation. It would probably be developed and mined if an electrolytic zinc plant were built in the Southwest. Similar ore has been developed at the Belmont Mine adjoining the Magma, and there are possibilities of developing ore of this type at the Black Bess Mine in Gila County, to the east of Superior. From the Magma and Belmont mines it is probable that from 10 to 20 tons daily of metallic zinc would be produced if an electrolytic zinc plant were built in the Southwest.

In the Vekol Mountains south of Casa Grande there has been blocked out at the Reward Mine, a small tonnage of complex copper-zinc sulphide ore of low grade. None has been mined, and the mine has been insufficiently developed to indicate the probabilities. The ore is associated with a large fault and replaces limestone beds contiguous to the fault. The mineralization is strong and the possibilities are good of developing a considerable tonnage.

Miscellaneous.—Other parts of the mountain and desert portion of the State contain small deposits of complex ores on which only superficial work has been done. If an electrolytic plant were built, it is probable that some of them would be developed into small regular producers.

New Mexico Deposits

Santa Fe County.—The largest developed complex ore deposit in the State, the Pecos Mine, is in this county, about 15 miles east of Santa Fe, in the southern end of the Sangre de Christo Mountains. The mine is owned by the American Metal Company, which has thoroughly equipped it for production. A 600-ton selective flotation concentrator is built, making lead, copper-iron and zinc concentrates. The ore is a mixture of silver- and gold-bearing blende, galena, pyrite, and chalcopyrite, replacing schistosed diorite. Large reserves are developed, and about 4,500 tons of zinc concentrates are made per month. These concentrates carry a considerable amount of gold and silver, and some lead and copper. They are now shipped to a re-

tort plant in the mid-west. The concentrates run 52 percent zinc, and would produce about 70 tons a day of metallic zinc at an electrolytic plant.

Grant County.—In this county in the southwestern part of the State there are two types of zinc-bearing ores. In one type the ore consists of blende-pyrite-magnetite mixtures, with low gold and silver content. These deposits are being mined and a considerable quantity of blende concentrates made, which are shipped to retort plants. It is possible that they could not be more economically treated at an electrolytic plant than at a retort plant. In the other type of deposits the ore consists of mixtures of blende, galena, pyrite, and chalcopyrite with high gold and silver content. One of these deposits, the Carlisle Mine, is being developed with promise of an eventually large deposit, capable of producing a considerable tonnage of zinc concentrates of the western type.

In this county, and in other parts of the State, in the southwestern mountain area, occur a number of complex ore deposits with very little work done on them. Some of them would undoubtedly be developed with the stimulation of an electrolytic zinc plant in the Southwest.

Southern California Deposits

The only producing complex ore deposits in southern California are the Catalina Island mines, operated by Wm. Wrigley, Jr. The ores are concentrated at a 130-ton selective flotation mill at White's Landing. Fifteen tons of 45 percent zinc concentrates are made a day and shipped to Belgium. This product contains 3.2 percent lead and 3.5 ounces of silver, and is an ideal product for an electrolytic zinc plant.

Several other localities contain partly developed complex ore deposits, now idle or being developed. The more important of them are the following:

The Big Buzzard Mine in El Dorado County, in the Sierra Nevadas, in which a vein 7 feet to 15 feet wide has been partly opened up, showing sulphide ores running 17 percent zinc, 2.65 percent copper, and $5 to $14 in gold. The property is now idle.

In Mono County, also in the Sierra Nevadas, two limestone replacement deposits, the Cooney Zinc Mine and the Lemont Group, have been partly developed and a large tonnage is indicated. In the first the ore is said to run 15 percent zinc, 10 percent lead, and from 4 to 6 ounces of silver. In the second, higher grade but smaller bodies of ore are indicated, which contain 20 percent lead, 14 percent zinc, and 4 ounces of silver. Both properties would be developed if a market were available for zinc blend concentrates.

In Orange County, south of Los Angeles, the Blue Light Mine is being worked intermittently on a vein 4 feet wide, of material averaging about 0.06 ounces of gold, 25 ounces of silver, 4 percent lead, and 13 percent zinc. The property would probably produce regularly if a favorable market were found for zinc blende concentrates.

Northwestern Mexico Deposits

In the State of Sonora, south of Arizona, there are two large complex ore deposits partly developed. One of them is now being diamond-drilled.

Gachi Mine.—This property is 45 miles south of Cananea, 4½ miles off the Cananea-Arispe road. There are 400,000 tons already partly blocked out, and several million tons probable. The ore occurs as large replacement bodies in limestone, and consists of massive galena, blende, and pyrite, running about 20 percent lead, 20 percent zinc, 4 ounces of silver, and $1 in gold. With modern selective flotation, high-grade concentrates could undoubtedly be made. The property could supply a 500-ton concentrator, which would yield 80 tons of 50+ percent zinc concentrates a day. The property is now being drilled.

Monstro de Plomo Mine.—This mine is 55 miles south of Nacozari and 12 miles southwest of Moctezuma. The ore occurs here also as limestone replacements. The occurrence is remarkably regular, the ore beds being from 6 to 8 feet thick, composed of massive sulphide ore, assaying about 20 percent lead, 15 percent zinc, 1.5 ounces of silver, and 20 cents in gold. The property has possibilities of upwards of half a million tons of ore. It could supply a 300-ton concentrator, which would produce about 30 tons a day of 50+ percent zinc concentrates.

Noche Bueno Mine.—This is a relatively small mine south of Nogales, which is operated intermittently with a 50-ton selective flotation concentrator. The zinc tails are now stored, the lead concentrates only being shipped. With favorable zinc concentrate disposal, it would yield about 5 tons of zinc concentrates a day.

General.—There are a number of complex ore deposits undeveloped and scattered which would probably be developed into small producers if a zinc plant were built in the Southwest. The yield from them would be sporadic, but in the aggregate they would furnish a considerable tonnage.

General Summary of Deposits

From the deposits listed in the foregoing paragraphs there would be available 86 tons of metallic zinc a day from developed properties now shipping western type concentrates to retort plants, 175 tons from partly developed properties, and 170 tons from promising prospects, divided as follows:

Locality	Net tons of metallic zinc a day Shipping	Partly developed	Possible
Arizona	20	60	70
New Mexico	60	40	40
Southern California	6	20	40
Northwestern Mexico	..	55	20
Total	86	175	170

Of the partly developed properties at least half the total could be counted on, making a certain available output of 173 tons of metallic zinc a day, which would be forthcoming at any reasonable metal prices if an electrolytic plant were built in the Southwest.

Power Requirements

In considering the site for a plant, the most important factor is cheap power. A centrally located plant in the mountains of Arizona or New Mexico would be faced by expensive fuel for steam generation or internal combustion engines. Power from fuel could not be produced for less than 1 cent a k. w. h., including depletion and depreciation charges. Laist and Caples * estimate the power consumption as 1.8 cents a k. w. per pound of zinc produced, and 1 cent per pound of zinc for labor, fuel, supplies, etc. With power at 1 cent a k. w. h. the total operating cost per pound of zinc produced would be 2.8 cents. After allowing for depreciation, return of capital, and profit, the necessary charges would be prohibitive. The only other available source of power is water power. Contracts for all of that already developed in Arizona have been made. The only immediately available source of water power is from Gila River below Coolidge Dam. The amount of constant power from this source is 13,700 k. w., nearly sufficient for a zinc plant of 100 tons capacity. The cost of building two dams, two power plants, and power lines would amount to about $4,000,000, making a power cost of about ½ cent a k. w. h., allowing for interest and return of capital. With power at ½ cent, the cost per pound of zinc would be 1.9 cents, a figure within the economic limit. A plant in Arizona would be limited to 100 tons capacity until the Colorado River is harnessed, an event, unfortunately, far in the future.

A second alternative for a site in the mountain area is in northwestern New Mexico near the coal fields. Coal at the mines costs about $3 a ton. At this price, assuming the production with powdered coal of 1 k. w. per pound of coal, and considering the high power factor attainable at an electrolytic zinc plant,

* Laist, Frederick, and Caples, Russel B. The Electrolytic Zinc Process, Handbook of Non-Ferrous Metallurgy, Ch. xxxii, P. 11, 1926.

power could be produced by turbo-generator sets for around 0.6 cent a k. w. h. for the 30,000 k. w. plant necessary for a 200-ton zinc plant, allowing for depreciation and return of capital in 10 years. The advantage of a plant at this locality would be the unlimited facilities for expansion if enlargement were found advisable. The disadvantage of the site is that it would be central only to two complex ore fields, that of Kingman and that of the Pecos mine. The freight from all other localities would be high, as concentrates would have to be routed over north and south connecting intermountain lines. The freight would also be high on residues to the nearest copper and lead smelters.

A third alternative for a site would be near Los Angeles, using petroleum or natural gas as a source of power. Power is being generated near Los Angeles for about 0.65 cents a k. w. h. at the plants, excluding distributing costs, with a low-power factor. With a high factor attainable with an electrolytic zinc plant, the cost should be reduced to one-half cent.

The advantages of this site are, (a) cheap first cost of plant, (b) good climatic conditions, (c) cheap ocean freights on zinc produced, (d) cheap ocean freights on residues to Selby, (e) unlimited facilities for the expansion of the plant. The disadvantage would be greater freight charges on concentrates from all deposits except those of southern California. This disadvantage would be partly, if not wholly, overcome by the advantage of cheaper freight to consumers on finished zinc. Zinc concentrate will average about 50 percent, and will take a lower rating than slab zinc. Intermountain freight rates are high, so that the freight on slab zinc from mountain points either east or west to consumers would be very much higher than from seaboard. Therefore the final charge against a pound of zinc f. o. b. consumers would be about the same for a plant either on the coast or at a central location in the mountains.

First Cost of Plant

Laist and Caples (see footnote, page 783) estimate that the first cost of a 100-ton plant will lie between three and three and one-half million dollars, with a slightly decreased unit cost for a 200-ton plant. A plant built in the Southwest, where mild climates prevail, should not cost so much as in the Northwest. It is probable that a plant of the Anaconda-Great Falls Trail type of 200 tons capacity would not cost over $5,000,000. The principal items entering into this cost are electrical equipment and sheet lead. The salvage value is high as compared to a smelting plant of any type.

Operating Costs

Assuming power costs at one-half cent a k. w. h., total costs per pound of recoverable zinc should be about as follows:

Power	$0.90
Labor, fuel and supplies	1.00
Total operating	$1.90
Depreciation, 4 percent	.12
Amortization and profit 16.34 percent	.55
Total cost, including profit	$2.57

The recovery on all constituents, including residues, is about 90 percent, so that charges, on a basis of paying at the market for 80 percent to 85 percent of all contained values, would be between $18 and $20 a ton for 50 percent concentrates, a figure well below retort plant charges on western type concentrates.

Conclusions

There is undoubtedly a sufficient supply of actual and potential western type zinc concentrates to justify the building of a plant or several plants with a total combined capacity of 200 tons. Eighty-six tons, almost half of this tonnage, is already being produced at retort plants, so that the additional zinc that would be thrown on the market would not be over 114 tons a day.

The most feasible location for a plant, considering all factors, would be near Los Angeles. The first cost would be less there, and the labor market superior, than for one in the mountain area. The disadvantage of higher freight rates on concentrates would be largely, if not wholly, offset by cheaper freight on finished zinc to consumers.

The total capital outlay for a plant at the three possible sites would be as follows:

Arizona

Power generation (15,000 k. w.)	$4,000,000
Zinc plant (100 tons)	3,000,000
Total	$7,000,000

New Mexico

Power generation (30,000 k. w.)	$3,250,000
Zinc plant (200 tons)	5,500,000
Total	$8,750,000

Los Angeles

Power generation (30,000 k. w.)	$3,000,000
Zinc plant (200 tons)	5,000,000
Total	$8,000,000

The risk in building a plant would not be great if contracts for the treatment of the zinc product of the present operators were obtained, and it is possible that enlargement above 200 tons would be found advisable. The field is practically a virgin one.

RECOVERY OF FINE GOLD BY AMALGAMATION

The frequency of cases of poor recovery of fine gold by the amalgamation process has led the United States Bureau of Mines to publish an information circular on the subject.

Experience has shown that in many cases error has been made because the true gold content of a particular sample or deposit was not known, states Edmund S. Leaver in Information Circular 6081. Fire assays of representative samples give accurate results and should be considered final in determining the gold content.

The best method for recovering gold depends on the form of its occurrence in the material to be handled. An experienced operator can obtain a good idea of the amount of free gold and can tell something as to the fineness of it by careful panning. The sulphides should be separated and cleaned from the free gold and gangue, and then weighed and assayed. If the sulphide carries gold, it is probable that part of the gold in the slimed portion is locked up with sulphides and will not amalgamate.

Silver-plated copper plates are generally used to recover the free gold from ore by amalgamation processes. For best results the plates must be kept as clean as possible. Mercury is worked into the surface of the plates until there is exposed a bright pasty amalgam that readily retains the gold as the ore pulp flows over the surface. To effect amalgamation each particle of gold must come into contact with the mercury; the attempt is made to accomplish this by passing the crushed ore and water in a thin layer over the entire surface of the plates and providing for a drop from each of the plates in the series.

Since its introduction the cyanide method of recovering fine gold from silicious ores has been the usual method employed for the recovery of gold lost in amalgamation processes. In many recently established plants cyanidation has entirely supplanted amalgamation for the recovery of fine gold.

Before expending any considerable time or money in attempting gold recovery, each prospect should be examined and approved by a competent operator familiar with the particular class of mining necessary, or by a competent mining engineer and metallurgist.

Information Circular 6081, "Recovery of Fine Gold by Amalgamation," contains several references to treatises, Government bulletins and magazine articles containing detailed information in regard to the subject matter of the circular, copies of which may be obtained from the United States Bureau of Mines.

EXPLOSIVES *and* THEIR PROPERTIES*

By I. GRAGEROFF †

AN analysis of the many properties that go toward best and most complete utilization of potential power of explosives

THE purpose of this paper is to present a discussion of the different properties of explosives. This should not be theoretical. The aim is to enable the mining man to do his own reasoning in selecting his explosives.

An explosive is composed of chemical substances capable of a rapid decomposition with evolution of large quantities of gases and heat.

Of the ingredients used, the most important are: Nitroglycerin, nitrocellulose, ammonium nitrate, nitrate of soda, woodpulp, flour, charcoal, etc.

Nitroglycerin, nitrocellulose and, to a smaller extent, nitrate of ammonia, could be detonated by themselves with a cap (basic explosives). The other ingredients mentioned could be divided into two classes:

(1) Carbon carriers, and
(2) Oxygen carriers.

As the names imply, the first to supply the carbon, and the second the oxygen to burn the carbon with. When mixed and touched with a match, the two will slowly burn. When mixed with nitroglycerin and set off with a match, the moist mixture (dynamite) will burn rapidly. When there is enough of the mixture, the rapid burning may be converted into an explosion.

Nitroglycerin is an ideal basis of explosives, because it is liquid and therefore is capable of perfect and uniform mixing in a very short time.

Where a plastic explosive is required, enough nitrocotton (guncotton) is added to combine into a thin gelatinous mixture (jelly). The dry ingredients (carbon carriers and oxygen carriers), the "dope," as we call it on the plant—is mixed with this jelly and made into gelatin dynamites, or gelatins, for short.

THE PRODUCTS OF EXPLOSION

The liquid nitroglycerin when exploded forms: Carbonic acid (CO_2), water (steam), nitrogen and oxygen.

At the moment of explosion:

One pound of nitroglycerin will be converted into 156.7 cubic feet of gas.

One pound of nitrocotton, the kind used in gelatin dynamites, will give after explosion 126.7 cubic feet of gas, consisting of carbon monoxide, carbonic acid, water and nitrogen.

One pound of ammonium nitrate will give on explosion 131.8 cubic feet of gas, consisting of water, oxygen and nitrogen.

One pound of black powder on explosion will give 51 cubic feet of gas, consisting of carbonic acid, carbon monoxide, hydrogen and hydrogen sulphide, etc.

For the purpose of designing, the composition of products of explosion is calculated from the chemical equations. This method is quite accurate, providing the ingredients are in proportions sufficient for complete combustion. In other words, there should be enough oxygen available to convert all the carbon present into CO_2, and all the hydrogen into water. The paper and paraffine in the shell should be taken into consideration. There are conditions, however, when the composition of products of explosion may differ from the calculated. This will happen under a number of different conditions—a frozen or partially thawed powder may not detonate completely, or, a dynamite may be shot with a weak or defective detonator, or, a gelatin dynamite may be rendered insensitive (phlegmatic) by keeping in magazines too long and then often gives an incomplete explosion even when a strong detonator is used, or, when too many sticks of explosives are put into the borehole with insufficient number of detonators. The explosives might be overcompressed and become insensitive. When powders are allowed to become wet, they become insensitive.

The high-grade powders like the 60 percent dynamites and gelatins must contain sufficient carbonaceous material to absorb the nitroglycerin; the quantity of absorbent required makes the powders unbalanced, and CO is likely to be given off during the explosion.

HEAT EVOLVED DURING THE EXPLOSION

This depends on the decomposition of gases given off during the explosion. Except elementary substances like oxygen, nitrogen, hydrogen, sulphur, most of the gases, liquids, and solids give off heat when they are formed.

CO when formed gives off 4.4 times as much heat as hydrogen sulphide. CO_2, 10.12 times as much. Water at 3,600 degrees F. (steam), 13.27 times as much as hydrogen sulphide.

Therefore, while the presence of carbon monoxide, carbonic acid and steam contribute heat, nitrogen, hydrogen and oxygen do not. This is why an excess of oxygen carrier over that required for complete combustion decreases the effective strength of an explosive.

One pound nitroglycerin develops 2,850 B. t. u.

One pound blasting gelatin develops 2,960 B. t. u.

One pound 40 percent gelatin develops 1,800 B. t. u.

One pound 35 percent gelatin develops 1,400 B. t. u.

One pound black blasting powder develops 1,200 B. t. u.

MAXIMUM TEMPERATURE OF EXPLOSION

There are no reliable means of determining experimentally the maximum temperature of explosion. One has to resort to calculations. Knowing the composition of the products of explosion, we can calculate the specific heat, and

* Presented to Ajo Meeting, Arizona Chapter, The American Mining Congress.
† Technologist, Apache Powder Company.

the total heat evolved. Should Q be total heat evolved at constant volume, and C the specific heat, then the temperature is:

$$T \text{ equals } \frac{Q}{C}$$

It is easy to see from this equation that the greater the C, specific heat, the lower the temperature. This is why an addition of an inert ingredient like kieselguhr lowers the temperature of explosion, since it does not add anything to the total heat—Q, but adds to the specific heat—C. An overbalance powder—that is, one that gives off uncombined oxygen—will not add to the Q, but has a value for C, and therefore lowers the temperature. The reasoning is the same as in the case of a furnace with an excess of draft.

The calculated temperatures are approximately:

	Deg.	Deg.
Nitroglycerin	3470 C. or	6280 F.
Blasting gelatin......	3540 C. or	6400 F.
40 percent gelatin....	3330 C. or	6025 F.
35 percent gelatin....	3020 C. or	5470 F.
Black powder	2770 C. or	5020 F.

The gases issuing out of the borehole at these temperatures make the shooting of these explosives very dangerous in gaseous and dusty coal mines. To avoid this danger, special explosives are designed, and our Government's Bureau of Mines recommends them. The permissible powders, as they are known, all have a maximum temperature of explosion below 3,600 degrees F.

There is not much danger from the high temperature of products of explosion in metal mining, except perhaps from fine sulphide dusts, where fires arising from dust ignition are not uncommon. Good stemming of holes, avoidance of excessive overloading of shots, and wetting of the mines will minimize the danger. There are three mining companies in Arizona using a permissible type powder for shooting old timbers in their mines.

Pressures Resulting From Explosions of Powders

The same chemical equation that was used for calculation of products of explosion, the heat evolved and the maximum temperature, gives the basis for computation of the volume of gas. One can obtain in this way the volume of gas at 0° C. and 760 mm. barometric pressure. Should it be V_0 and maximum temperature of explosion—t, then the volume occupied at the moment of explosion:

$$V \text{ equals } V_0 \frac{(273+t)}{273}$$

One can arrive in this way to the following figures:

	Cu. ft. gas
One pound nitroglycerin will give at 3,540 degrees C............	156.7
One pound nitrocotton (kind used in gel. dyn.) at 1,940 degrees C.	126.7
One pound ammonium nitrate at 2,120 degrees C...............	131.8
One pound black blasting powder at 2,770 degrees C............	51.0

Pressure Developed

Knowing the volume occupied by gaseous products of explosion, and the volume occupied by the charge of powder in the borehole, and knowing the atmospheric pressure, one can arrive at the pressure developed by a unit weight of explosive occupying originally one unit of space; that is, taking the charging density as 1. The greater the ratio between the volumes before and during the explosion, the greater is the pressure developed. The explosion is never instantaneous.

Rate of Detonation

Should a length of powder cartridge of, say, 10,000 ft. require one second for complete explosion from end to end, one can say that the rate of detonation for this particular explosive is 10,000 ft. per second. This property of explosives is of extreme importance. The crushing effect of an explosive depends on developing of the maximum pressure in a minimum time. Besides this, the slower the powder detonates, the greater the cooling of hot gases caused by contact with the much colder walls of the borehole, and therefore loss of available energy.

This loss of heat in case of a high explosive is not great. As an instance, it was figured by Herlin (Z f G S & S, 15 June, 1919, pp. 238) that a powder developing a maximum temperature of 2,700 degrees C. (4,900 degrees F.), and having a rate of detonation of 5,500 meters per second (20,340 ft. per second), occupying 39 in. in the borehole of 1.18 in. diameter, would lose through cooling of rock walls less than .004 B. t. u. For a powder with a maximum temperature of 3,500 degrees C. (6,330 degrees F.), and a rate of detonation of 3,400 meters per second (11,150 ft. per second), we calculate the loss under the same conditions to be about .01 B. t. u. For black powder with a temperature of explosion of about 2,400 degrees C. (4,350 degrees F.), and a rate of detonation of 427 meters per second (1,400 ft. per second), the loss under the same conditions is .06 B. t. u.

The strength of the detonator affects the rate of detonation considerably, especially in case of gelatin dynamites. A very interesting group of results were obtained by Comey (reported to Seventh International Congress of Applied Chemistry in London, 1909, Section III B).

RATES OF DETONATION

Percent strength	Straight dynamite	Gelatin dynamite (shot with cap)	Gelatin primed with 40 percent str. dynamite	Ammonia powder shot with cap
	m/s*	m/s*	m/s*	m/s*
75	6265	2165	6999	....
60	5973	2104	6606	4381
55	....	2355	....	....
50	5348	2279	5544	4381
45	5032	2230	....	....
40	4848	2278	....	4123
35	4605	2484	5122	3960
30	4172	....	....	3556
25	3296	....	....	3187
20	3197	....	....	....
10	2103	....	....	....

* m/s—Meters per second.

Comey finds that the rate of detonation in his tests with powders did not change perceptibly with caps of different strength. We assume that he reported tests on freshly made powders. It is quite reasonable that with older and therefore less sensitive powders, a higher strength detonator is required.

A phenomenon worthy of mention is that, although the rate of detonation in explosives is increased at first with the volumetric density (weight of explosives per unit volume), a continued compression will decrease it, until the powder fails to detonate. The French investigator, Dautrich, showed that clearly. We might give here his findings with a dynamite consisting of 75 percent nitroglycerin and 25 percent kieselguhr:

Volumetric density	Rate of detonation in meters per second
0.63	1991
.79	2397
.85	2563
1.34	3670
1.54	5230
1.62	6794
1.69	4207
1.71	2460
1.74	Failure

Since the explosion is never instantaneous, but proceeds from layer to layer, with ever-increasing pressure, it is easy to understand that the powder not yet exploded is getting denser and denser and that a maximum of density might be reached where that overcompressed portion will not explode. Even mercury fulminate (used in caps) could be overcompressed so that it does not detonate. Herlin—Dec., 1913—Z G S & S, pp. 451.) It is compressed to death, as a Swedish engineer calls it. This overcompression of a portion of an explosive charge probably takes place where a great number of sticks of powder are placed in a borehole with only one detonator. It is more likely to happen with gelatin than with dynamite, because gelatins are more dense to start with.

Other factors will influence the rate of detonation. (*Continued on page* 789)

NEWELL G. ALFORD
Editor

Practical Operating Problems of the Coal Mining Industry

BETTER AIRWAYS *versus* NEW FANS

Most Ventilating Troubles Originate Within 2,500 Feet From Intake And Outlet—Revision Of Airways Frequently Preferable To New Fan Equipment—Large Airways And Low Velocities Always Desirable

By W. J. MONTGOMERY *

THIS subject is one that is of vital interest to every mine operator and to those in charge of mine ventilation. It might seem that the subject is rather inappropriate for one to discuss whose work has been principally along the line of design and sale of mine fans. The presentation of these data is only putting in writing that which the writer has tried to emphasize verbally during the past 25 years in connection with the sale and engineering data on mine fans.

Pure air is an excellent investment, whether it is in a mine, public building, your home, or your office. The effect of inadequate ventilation can be traced to children who are housed in the tenement districts of our large cities; to those who toil in contaminated air, and are unable to do a full day's work. The effect of poor ventilation may also be traced to our sleeping rooms, where, without a sufficient supply of pure air, one gets up feeling unfit for the day's labor; and to all public meeting places where poor ventilation leads to the contraction of many fatal diseases. Then why not provide adequate ventilation means for the proper ventilation of our mines? The composition of the air in our homes, in our offices, factories, public buildings and mines should approach the open atmospheric conditions as nearly as possible.

The greatest evils in the ventilation of mines are insufficient and contracted air ways, the promiscuous use of stoppings, and the neglect of defective ones.

In the development of new mines particular attention must be given and provisions made at the intakes and at the outlets to take care economically of the maximum volume of air required to ventilate the mines. A general survey of a large number of mines shows conclusively that the main source of trouble is found within a radius of 2,500 ft. from the intakes and outlets. It is inconsistent to have inadequate area for the intake and return and at the same time provide for many times this area far within the mine. The old saying, "A chain is only as strong as its weakest link," applies here as well. The 2,500 ft. section is the weak link in the ventilation system.

It is a most difficult task to teach the necessity of providing ample air ways for the ventilation of mines. On the other hand, if questions were asked pertaining to similar duties, such as the following, they would be readily answered.

Why does a small furnace pipe carry insufficient volume of warm air to heat a large room properly? Why are the channels of the Mississippi River being enlarged? Why are many large cities enlarging their water mains to meet the growing demand for more water? Did you ever condemn your water company for not providing enough pressure at the faucets and later find the water pipes clogged in your house? These clogged water pipes give just the same results at the faucets as do clogged air ways, delivering ventilation at the face of the workings. Why do you provide two #0000 wires to carry 100 h.p. for a distance of 1 mile in your mine instead of using one #0000? Is it not because there is too much resistance, which causes a large drop in voltage (pressure)? Then, why condemn your fan for its failure to produce its rated volume until an investigation is made?

It is not necessary to traverse all the mine to make this investigation. In fact, a short test on the ventilating equipment will give more information than days of exploring the air ways. Take the speed of the fan, read the water gauge and ascertain if they correspond to the specifications of the fan manufacturer. If the gauge is correct (it may be somewhat higher than specified with some makes of fans), then short circuit a sufficient volume to bring the fan up to its rated capacity. Take the speed of the fan again, and if the manufacturer's specified pressure and volume are obtained it is no longer necessary to condemn the fan, but look toward improvements of the air ways.

It has been the custom to send out specifications for a new fan when the

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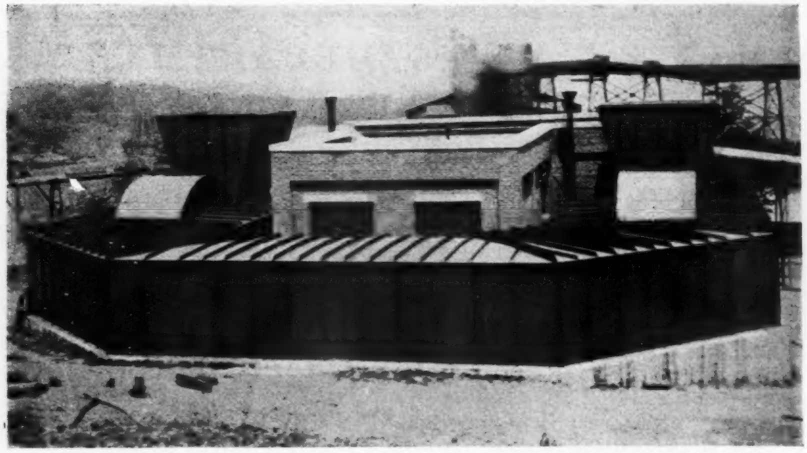


Two double inlet exhaust fans connected to an air shaft with steel drifts. The fans are so installed that a single house is provided for both drives. One fan is held as a spare and the drifts are provided with cut-off doors, enabling a quick change from one fan to the other

present fan no longer delivers a sufficient volume. In a few cases this is a correct procedure, but in the majority of cases it is not. If the present fan has a normal rated capacity of 200,000 cu. ft. at 3-in. gauge, and it is only delivering 100,000 cu. ft. at this pressure, it is no uncommon practice to send out inquiries for a new fan to deliver 200,000 cu. ft. at 3-in. gauge. The fan manufacturer must be alert on these inquiries, otherwise there would be more grief than exists today in the ventilation of mines. This problem contains one of the basic principles of mine ventilation, namely, one make, size or type of fan can not deliver more air than any other make, size or type at the same gauge while the conditions in the mine remain the same. The water gauge or mine resistance is a function of the mine, and if it requires 3-in. pressure for a certain fan to deliver 100,000 cu. ft. it will require the same pressure for any other make. In order to deliver 200,000 cu. ft. with the same mine conditions, it will require 12-in. gauge. This pressure is prohibitive, and must be solved by sinking a new shaft, by enlarging and driving new air ways, and by splitting the air, and not by the purchase of a new fan. There is nothing further from the truth, in many instances, than the familiar saying, "It is cheaper to purchase a new fan than clean air ways."

A comparison between a mine fan and a pump for handling water is quite interesting. The air ways in a mine may be likened to a pipe line which carries water. If a pump is purchased with a capacity of 500 gallons per minute and connected to a pipe line of 1 in. diameter, very few would expect this pump to deliver 500 gallons of water. Another 1 in. pipe line is added and the volume of water is increased, and so on until the pump is brought up to its rated capacity, while its speed remains constant. Exactly the same principle applies to a mine fan. The ventilating equipment may have a rated capacity of 200,000 cu. ft. per minute delivered against a resistance of 3-in. water gauge at 170 r. p. m., but because of insufficient air ways the volume delivered may be 50,000 cu. ft. or any other volume between 0 and 200,000 cu. ft. An additional air way is added and the volume is increased. This may be carried out until the volume is increased up to the normal rated capacity of the fan. It must be reasonable to assume that an entire closure of the air way would prevent any air going through the mine; therefore, if the air ways are partially blocked, the volume will be less than otherwise.

The next step to consider is what constitutes sufficient air way capacity. This may be answered briefly by the following tabulated data computed from an average air way 12 ft. by 5 ft. with sectional area of 60 sq. ft.:

Distance of travel (feet)	Allowable velocity (feet per minute)
100 to 500	2,000
500 to 1,000	1,400
1,000 to 2,000	1,000
2,000 to 4,000	700
4,000 to 8,000	500
8,000 to 12,000	400
12,000 to 16,000	350
16,000 to 22,000	300

Above 22,000 ft. it is time to reduce the travel of air by sinking an air shaft or driving out new openings.

The air ways in a mine are always rough. The air is baffled by the crosscuts, by the fallen slate and rock in the roadbed, and by the timbering along the air ways. These obstructions may be compared with rocks and baffles in the bed of a stream. When the water is low and moving at a slow rate of speed, one does not notice the retarding effect, but when the stream is swollen by rains and a high velocity is necessary to carry the volume, the water dashes against and leaps over the obstructions in its path. The same conditions exist in a mine, though the movement of the air is invisible, and is not brought forcibly to the notice of the observer.

A few years ago the Mine Ventilation Committee of the American Mining Congress Standardization Division made several recommendations pertaining to improvements and standards of mine ventilation, and one of these recommendations dwelt in considerable length upon the advisability of providing large air ways and keeping low velocities of air to reduce the resistance. Some comments on these recommendations have been noted along the following lines. An explanation which shows the advisability of large air ways and reducing frictional resistance does not seem to have a place in the ventilation standards. Such subjects are supposed to be primary knowledge on the part of any mining engineer or mine foreman. The air velocity on haulage roads and passages regularly traveled should not exceed 800 ft. per minute, but in air courses not traveled except for inspection it may be 1,200 ft. per minute.

It is very evident that in making these comments only the personal effects were considered, and the real facts which prohibit such velocities were overlooked. If any mine operator figures on these velocities in the general layout of a mine of any material size, less than one-half the required volume can be obtained under a reasonable pressure. It only takes a few figures to prove that a velocity of 1,200 ft. is prohibitive for the average mine, and will surely lead to a defective ventilating system. It is no uncommon practice to find main air ways 8,000 ft. long, that is inby 4,000 ft. which gives a travel of 8,000 ft. Now take a mine with this travel and assume an air way 10 ft. by 6 ft. taking 1,200 ft. velocity and using a coefficient of friction .000,000.01, we have the following calculation:

$$\frac{.000,000,01 \times (1200)^2 \times 256.000}{5.2 \times 60}$$

This gives a gauge of nearly 12 in., which in itself is altogether prohibitive, without taking into consideration the pressure necessary to sweep the face of the workings. Now suppose this air had been split in this mine and carried the same distance in two air ways, each 12 ft. by 6 ft., which would give 500 ft. velocity. Since both air ways are of the same size, and same periphery, the same pressure is required for each air way, consequently it is only necessary to figure the pressure for the one air way, and the following statement applies:

$$\frac{.000,000,01 \times (500)^2 \times 288.000}{72 \times 5.2}$$

This calculation gives a pressure of approximately 1.9 in. and is in line with table of velocities for a distance of 8,000 ft. If both air ways were calculated, the problem is stated as follows:

$$\frac{.000{,}000{,}01 \times (500)^2 \times 576.000}{144 \times 5.2}$$

The result is the same, because while the rubbing surface is doubled, yet the area is doubled. The calculation is given here to emphasize the fact that, in figuring resistance, only the longest or most difficult split should be taken into consideration.

During the past 25 years in this line of work many interesting problems have come up, and while many are conversant with these fundamental principles, yet very few apply them. One of the questions most commonly asked, "Will the volume of air flowing through a mine be doubled with the application of an additional fan of the same size and power consumption, provided each fan works on its own individual section of the mine?" This question may apply where a fan is ventilating two or more seams of coal or where it is contemplated to divide a large mine into two independent mines and ventilate each separately. The question can always be answered in the negative where the present ventilating equipment has a capacity equal to the capacity of the present air ways. Assume, for example, that a fan has a capacity of 200,000 cu. ft. at 3-in. gauge ventilating two seams of coal with 100,000 cu. ft. passing in each seam. Conditions require 200,000 cu. ft. in each seam. Can this be obtained by the installation of a duplicate fan on a new air shaft and ventilating the seams separately? No; each fan will deliver approximately 50 percent of the rated capacity, and the power consumption will be greater than when one fan is producing the total ventilation. In very few cases where there is a high resistance in the air shaft, the sinking of an additional shaft at or near the site of the present shaft would relieve conditions somewhat, but as a general proposition there is nothing gained. The same statement applies where it is contemplated to divide a large mine into two independent ventilating districts. If the present fan has a capacity equal to the capacity of the air ways in both districts, the addition of another fan would be of no value. It has been noted in some mines where two main splits are taken off at the bottom of the air shaft, but because of insufficient ventilation it is contemplated to seal one off, believing that the total ventilation which is traveling in both splits will immediately be delivered to the active section of the mine. The sealing off of this section only reduces the number of air ways for the air, and the volume will be reduced in practically the same ratio as the air ways are reduced.

At the present time, many mining companies are pursuing a very stringent course in their purchase of new equipment. Many second-hand fans are being installed at mines without any consideration as to their practicability for the particular mine in question. The economy of such purchases is more than doubtful. One recent installation which has caused considerable comment was when a fan which originally delivered 150,000 cu. ft. per minute at 3-in. pressure at 200 r. p. m. was moved to another mine. It was here again driven at 200 r. p. m., yet only a volume of 75,000 cu. ft. was obtained. This was exactly the same duty as performed by the fan displaced. An expenditure of nearly $3,000 was made on the installation which was a total loss. The former mine had only one-fourth the resistance of the latter, and consequently passed twice as much air as the latter at the same pressure. It is really surprising that these monumental errors should be made; but as one comes into contact with many of those having charge of this important work, the surprise is that things are not much worse. Why are our mining men not educated in this country to maintain the high standard of mine ventilation that exists in many foreign countries? The foreign mines in general are much more difficult to ventilate than our mines, yet disastrous explosions are very few. It is because mine owners are taught the importance of making large air ways and keeping them clean; of building substantial stoppings and keeping them tight; of splitting the air and ventilating their mines in districts; of building overcasts and providing easement on each side; of maintaining tracks on their main air ways for removal of falls and maintaining reasonable low velocities on all main air ways.

Much may be written about the importance of large air ways and maintaining low velocities in a mine, but nothing will bring this matter home more quickly than a cost tabulation of the ventilating equipment. The pressure varies as the square of the velocity and the power varies as the cube of the velocity. Therefore, to double the air in a mine requires eight times the present power consumption. This emphasizes the fact that during the first few years development of a mine where only about one-half the volume is required, the power consumption must be held at a low figure.

The relative powers required to pass equal volumes of air through air ways of the same length but of different areas and perimeters vary as the perimeter divided by the cube of the area. Assuming that an air way 14 ft. by 7 ft. requires 10 horsepower, the following tabulation is obtained:

Size of airway		Perimeter in ft.	Area sq. ft.	Relative powers	Cost/year, at 1½c. K.W.H.
14′ x 7′	......	42	98	10.	$980.00
13′ x 6′–6″	......	39	84.5	14.6	1,430.00
12′ x 6′–0″	......	36	72	21.6	2,120.00
11′ x 5′–6″	......	33	60.5	33.3	3,260.00
10′ x 5′–0″	......	30	50	53.7	5,260.00
9′ x 4′–6″	......	27	40.5	91.	8,920.00
8′ x 4′–0″	......	24	32	164.	16,100.00

The difference in cost in maintaining ventilation through these two areas must appeal to every operator, engineer, or those in charge of laying out or maintaining a system of mine ventilation. It is safe to say there are more mines today whose average sectional area on each air way approach the 40.5 sq. ft. area than those which approach the 60.5 area.

The foregoing has been devoted chiefly to show the economy and practical necessity of keeping and maintaining ample

A completely steel-housed fan with steel motor house, shown at the left, displaced an old-time wooden-housed fan at the right. A grave danger from fire has been eliminated, and at the same time the power-saving factor paid for the fan within a period of one year

A 6-ft. double inlet fan is shown in the foreground. This fan displaced a 16-ft. fan, shown in the background, with a saving of over $4,000 per year in operating expense

air way capacity. But air will travel where the least resistance is offered and without substantial stoppings; it will find its way out on the return without effecting its purpose at the working faces. This fugitive air assumes very great proportions in many mines, and while the fan may be delivering twice the quantity necessary for the working faces, this is no indication that the mine is properly ventilated.

New fans are sometimes purchased to handle a much larger volume, but the percentage of the increased volume reaching the active workings is almost insignificant as compared with the enormous increase of power applied. The following table was computed from 16 different mines, showing the amount of air delivered by the fan and the quantity at the last crosscuts:

Mine No.	Quantity of air at fan, cu. ft.	Quantity at last crosscut, cu. ft.	Pct. reaching last crosscut
1	119,533	18,232	15.3
2	120,410	16,737	13.9
3	65,300	6,160	9.4
4	120,000	40,000	33.3
5	64,700	15,600	24.1
6	59,827	7,035	11.7
7	96,000	22,140	23.0
8	50,400	3,840	7.6
9	38,160	12,300	32.2
10	35,290	5,125	14.5
11	77,364	9,600	12.4
12	160,276	37,672	23.5
13	28,130	2,380	8.5
14	90,000	12,000	13.3
15	62,240	10,950	17.6
16	69,400	23,250	33.5

A new fan at any of these mines would be practically useless unless conditions were changed inside of the mine. Take, for example, No. 1 mine, where it would be necessary to provide a new fan with a capacity of 239,066 cu. ft. to produce 36,464 cu. ft. effective duty. This would involve the expense of a new fan, driving units and eight times the power consumption required for the present fan. It is much better and cheaper to provide stoppings as air tight as possible and reduce the leakage at doors, crossings, and brattices.

It is true that the conditions as shown above in this tabulation have been greatly corrected in many mines today, but there is still much room for improvement in the majority of mines. When one looks at the tables and notes the lack of effective ventilation in these mines, it is of little wonder that the partial eliminations of crosscuts, consequently stoppings, and the use of auxiliary blowers are advocated by many engineers.

In the development of mines two intakes and two returns should always be provided for the main air ways and arranged with a solid pillar between them, as far as it is practical without breakthroughs and stoppings. If these air ways are insufficient to carry the required volume according to velocity tables, additional ones must be provided. Hundreds of thousands of dollars are paid annually in power bills for the fugitive air which does no one any good. It only tends to create high velocities on the intakes and returns near the fan and absorbs the pressure which should be available to sweep the working faces with a sufficient supply of fresh air. A very large percentage of our mine explosions is due to insufficient volume of air to dilute, render harmless, and carry away the gases emitted from the coal strata. But the primary cause is usually due to a lack of air-way capacity to carry the required volume of air for the safe and economical ventilation of the mine.

Our costly warnings during the past years have emphasized the great necessity of utilizing every means to raise the standard of mine ventilation to a higher plane. No money expended brings better returns than the expenditure made on air ways, stoppings, overcasts, and brattices in establishing and maintaining a first-class system of ventilation.

The importance of large air ways and tight stoppings has been fully covered in the preceding paragraphs. Keeping these ideas in mind, one wonders whether it is ever economical or practical to install a new fan. There are at least four main conditions to be considered where the replacement of mine fans should receive very careful consideration:

First, where the present fan is entirely too large, and its design is unsuited to the mine in question.

Second, where the fan is too small and the mine has outgrown the normal capacity of the fan.

Third, where a mine is ventilated by a fan built of combustible material and is a source of danger to those employed underground.

Fourth, where disc fans are employed in series.

There are probably more mine fans in operation today which would come under the first heading. Twenty-five years ago it was just as rare to find an electrically driven fan as it is today to find a steam-driven one. The fans at that time were usually directly connected to engines, and it was necessary to construct them large in diameter to give sufficient peripheral speed to produce the required pressure without overtaxing the safe and economical speed of the engine. Besides, the belief prevailed that a fan was only capable of delivering its cubical contents every revolution, while with our modern fans it is not uncommon to find them delivering three to four times their volume ratio. The inlets of the modern fan are made much larger and the tight-fitting scroll found in the large Guibal type has given way to an Archimidian spiral in the modern fan. Instead of obtaining mechanical efficiencies from 30 to 40 percent with many old-time large fans, efficiencies from 70 to 80 percent are obtained with the newer types.

There are also many modern fans, however, operating on mines which should be either consigned to the scrap heap or held as a stand-by unless the mines are brought up to the capacity of the fans. The latter is a very slow and costly solution, but without question it is the better. The large fans are purchased with the idea in mind of having an extensive development and a sufficient supply of air. The failure to obtain the latter can be traced to two main sources. First, the operator or those in charge of the mine development were not educated, and, generally speaking, they are not today, to the great necessity of providing sufficient air-way capacity. Second, in the great haste to get the new mine on a paying basis, no more air ways were driven than were absolutely necessary to get out quickly a large production of coal. These facts explain why, as previously stated, the main trouble in air-way capacity is found within a radius of 2,500 ft. from the inlet and outlet of the mine. If it is found not practical to bring the air-way capacity of the mine up to at least 70 percent of the capacity of the fan, then install a new fan whose characteristics are more nearly in keep-

ing with that of the mine. Many of these so-called modern fans are operating at 20 to 40 percent capacity and with a mechanical efficiency in the same range. The excess cost of power operating under these conditions, in many cases, would pay for a new efficient fan within a period of one year. The old fan may be held as a stand-by, because a spare fan is an excellent investment. One never knows when a fan shaft will break or a bearing burn out. A breakdown on the ventilating system puts the mine out of commission, and the direct loss through the shutdown is the main item to consider, not the cost of repair to the ventilating equipment.

The second condition, and not much less important, is where the present fan is operating far above its normal capacity. In most cases of this kind the fan has been purchased with the idea in mind of being only a temporary installation, to be used until more air is required. After the fan is once installed it seems to be the custom to keep it in operation almost indefinitely, or at least so long as it is capable of furnishing sufficient ventilation, irrespective of how much it costs for excess power. One often hears a remark about some small fan delivering a very large volume of air and expressions relative to its wonderful efficiency. These are true as far as volumetric efficiency is concerned; however, power bills are not based on volumetric efficiency, but on mechanical efficiency. If a fan is designed to handle 75,000 cu. ft. at 3-in. water gauge, and if the temperament of the mine or its characteristic is 150,000 at 3-in. gauge, the fan will handle the latter volume provided it is operated at a peripheral speed much higher than that actually required to produce the gauge under normal rating for the fan. A part of the effective depression produced by the blades is consumed in drawing the air through the fan itself, and this is done at the expense of a large power consumption. These fans should be immediately replaced by new ones whose capacities are more in keeping with that of the mines.

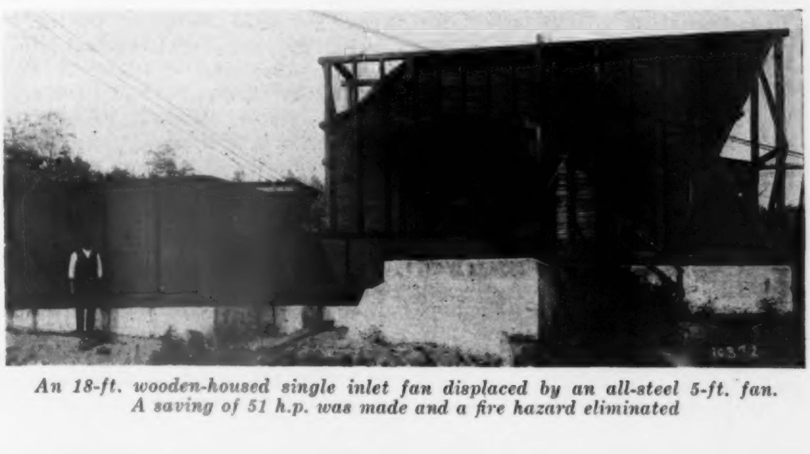
The advisability of installing a centrifugal fan as a temporary measure is more than questionable. When the mine is new the air ways are short and a low resistance is offered to the passage of air. It is a fundamental principle that the lower the gauge for a certain volume of air, the larger the fan should be to handle this air at a low speed, consequently a low power consumption. The next objection is the fact that the temporary installation is usually made at the most advantageous place in relation to the mine opening. When the time comes for a permanent fan installation, it is desired to keep the mine in operation, and often the permanent fan is placed at a disadvantage. This objection, of course, could be removed by the proper installation of the temporary fan, but experience has proven that no thought is given to the installation of the permanent fan when the temporary fan setting is made. The psychological effect has quite a bearing on the question. Too many, knowing their fan is only a temporary affair, are forgetful of their mine conditions. They believe when the time comes when a much greater volume of air is required, a new fan will solve their problem. In many of these cases a new fan will not do much good, and the operator learns for the first time that he has been developing his mine under a wrong impression. If the permanent fan had been installed in the first place, no doubt the lack of ventilation would have been brought to his notice earlier in the development stages and corrective measures taken on the air ways to insure an adequate supply of air.

The third, but no less important, condition to be considered concerns the wooden housed fans, which are veritable fire traps. The fragile siding used for their construction and the grease-soaked lumber which is used to support the bearings may catch fire at almost any time. They are usually wasteful in power consumption, incapable of producing sufficient pressure to properly ventilate a mine of material size, unreliable in operation, and a grave source of danger to those whose lives depend on continuous and effective ventilation. Mines are found with the "Safety First" sign posted in conspicuous places and yet a wooden housed fan is supplying the very breath for hundreds of miners. Costly experience, both from the loss of lives and of money, has emphasized the fact that all fans, housing, and mine connections should be built of noncombustible material.

A fourth condition, but not so serious as the preceding ones, should receive at least a passing notice. A number of mines are ventilated with disc fans and this type works very successfully on small mines, especially where they are driven to the outcrop frequently, and a very low resistance or water gauge is encountered. They are also used for the development of large mines, but objections to their use here are the same as outlined for the small centrifugal type. Abuse occurs in the use of some of these fans. Just as soon as it is discovered that the disc type of fan no longer is capable of producing sufficient pressure, another disc fan is added in series. Sometimes three or four of these fans are operating in series on a mine; this is wasteful power consumption. The efficiency of this type ranges from 30 to 50 percent, whereas the efficiency of the centrifugal type averages around 70 percent or better. Besides, it is much more economical to operate one unit for a certain amount of work than several, even if the efficiencies were the same. Where it is necessary to place these fans in series, a centrifugal type should be substituted of sufficient capacity to ventilate the mine properly and economically.

The past few years have seen the elimination of power plants at the mines to a great extent, and substitution of power furnished by central stations. There is always more or less uncertainty as to the continuous service from these stations, and many means have been devised for the continuous and uninterrupted operation of mine fans. A very careful consideration should be given to the complete duplication of the fan where the installation calls for an auxiliary drive. A fan installation should be as fool-proof as possible; equipped with driving machinery and mechanism that will not get out of order; and so constructed that constant attention is reduced to a minimum. Such an installation calls for two fans. It is not absolutely necessary to have both fans of the same capacity, but each fan should have its own independent drive—thus eliminating all clutches, cut-off couplings, and complicated mechanism which is likely to cause trouble in the future.

If it is found not practical to make a



An 18-ft. wooden-housed single inlet fan displaced by an all-steel 5-ft. fan. A saving of 51 h.p. was made and a fire hazard eliminated

duplicate fan installation, and it is desired to have protection in case of failure of electric current, it is recommended that a generator be installed and connected up to a gas or gasoline engine. This power source should be wired up to the switchboard so that immediately upon the failure of the electrical current the engine may be started, switch thrown in and current delivered to the fan motor from the auxiliary power unit. This will eliminate clutches and afford a good protection from the failure of the main power source.

In cases where it is found that the expense is too great to install a gas engine for the full capacity of the fan, a 40-cycle generator may be used. This frequency will operate the fan at two-thirds speed, where the motor is a 60-cycle machine, and will give two-thirds the former volume of air with only one-third the power consumption. The above arrangements should receive very careful consideration before a fan is installed at a new mine, and where the source of current is from some central power station.

It is my opinion that no phase in the mining industry has been so neglected as the proper and economical ventilation of mines. It is not always, by any means, the willful neglect on the part of those having charge of this important work, but a woeful lack of knowledge and the dearth of information on the subject. The Bureau of Mines has done excellent educational work in many phases of the mining industry, but why have they refrained to a great extent from that phase which, besides insuring the health of the miners and increasing the production of the mine, has the greatest bearing on protecting the lives of the miners and the property in the mine, and in fact on the very life of the mine itself? These data pertaining to air ways, air velocities and fans coming direct from the Bureau of Mines would certainly carry more weight and make a better impression than coming from one whose occupation has been chiefly in the design and sale of mine fans.

CARNEGIE INSTITUTE LINING UP ATTRACTIVE PROGRAM FOR COAL CONFERENCE

More than a hundred speakers, representing twelve countries, are tentatively listed to present papers at the Second International Conference on Bituminous Coal, to be held under the auspices of the Carnegie Institute of Technology in Pittsburgh, November 19 to 24, 1928, according to President Thomas S. Baker.

According to the plans, 10 major subjects are listed for discussion in addition to the addresses of a general nature to be presented by Lord Melchett (Sir Alfred Mond), the British capitalist; Georges Claude, the eminent French scientist; Professor Fritz Hofmann, the German scientist who makes synthetic rubber from coal; Dr. F. zur Nedden, of Germany; F. G. Tryon, of the U. S. Bureau of Mines, and others.

Major subjects to be discussed, it is expected, will include "Pulverized Fuel," "Gas Production," "Liquefaction and Hydrogenation," "Fertilizers," "Origin, Composition and Classification of Coal," "High Temperature Carbonization," "Combustion in Furnaces," "Purification and Cleaning," "Tars and Oils," and "Low Temperature Processes."

Germany will apparently be represented by the largest delegation, with about twenty of her most distinguished scientists and engineers in attendance. France, England and Canada will also be represented by comparatively large numbers of scientists who have been identified with the latest discoveries in coal research. Other countries that will be represented on the program of speakers are Russia, Italy, Japan, Austria, Denmark, Belgium, and Jugo-Slavia. In addition, delegates have been appointed to represent governments and scientific organizations in Chile, Cuba, Czechoslovakia, Norway, Poland, Roumania, and Spain.

Approximately 60 of the 103 speakers already listed to participate in the proceedings, the announcement points out, will come from outside of the United States.

Several of the major subjects and some of the speakers under each follow:

Pulverized Fuel

"Pulverized Fuel Conveying and Firing, with Special Reference to Locomotives and Marine Boilers," Dr. George E. K. Blythe, London, England; "Fuel Tests and Plant Operation," Dr. Ing. M. Dolch, University of Halle-Saale, Germany; "Adaptation of Pulverized Fuel to Marine Boilers," C. J. Jefferson, United States Shipping Board; and Commander J. J. Broshek, United States Navy; "The Powdered Coal Locomotive of the General Electric Company," Baurat Walter Kleinow, Henningsdorf, Germany; "Burning Bituminous Coals in Pulverized Form," Henry Kreisinger, New York; "A Diesel Engine Using Powdered Coal" (tentative), Rudolph Pawlikowski, Germany; "Thermodynamic Bases of Pulverized Coal Combustion," Dr. Ing. P. Rosin, Dresden, Germany.

Origin, Composition and Classification of Coal

"The Classification of North American Coals," A. C. Fieldner, Bureau of Mines, Washington, D. C.; "Coal and Economic Development of New Turkey," or "Black and White Coal in Austria," Dr. Bartel, Granigg, professor at the Mining University, Leoben, Austria; "Origin of Coal," Professor E. C. Jeffrey, Harvard University, Cambridge, Mass.; "Relation Between the Fossil Combustibles and the Gaseous Products Resulting from their Destructive Distillation," Professor Paul Lebeau, Paris; "An Analytical Method for Characterizing Coals by Extraction with High Boiling Organic Compounds," P. E. Raaschou, Copenhagen, Denmark; "General Considerations on the Origin and Nature of Bituminous Coals," and "The Nature and Properties of Siberian Bogheads," Dr. George L. Stadnikoff, Moscow, Russia; "Recent Developments in Coal Research," Dr. Reinhardt Thiessen, Bureau of Mines, Pittsburgh, Pa.

Liquefaction and Hydrogenation

"Recent Scientific Developments in Coal Research," Dr. Friedrich Bergius, Heidelberg, Germany; "Oil Extraction from Coal" (tentative), R. H. Crozier, London; "The Hydrogenation of Organic Substances at High Temperature and Under High Pressure in Presence of Non-Hydrogenating Catalyzers," André Kling and Daniel Florentin, Paris; "The Hydrogenation of Tars," Professor Hugel, Strasbourg, France; "Hydrogenation of Coal," Dr. Carl Krauch, Germany.

High Temperature Carbonization

"Expenditure of Heat in the Coking Process," Dr. Ing. Ernst Terres, Germany; "The Dry Quenching of Coke," D. W. Wilson, vice president, Dry Quenching Equipment Corporation.

Purification and Cleaning

"Interpretation of Float and Sink Data" (tentative), Byron M. Bird, Southern Experiment Station, Bureau of Mines, Birmingham, Alabama; "Progress in the Field of Removal of Sulphur from Gases," Professor Doctor Franz Fischer, Mulheim-Ruhr, Germany; "Theory on Washing—Wet or Air Cleaning, Rheolaveur or Jig," A. France, Liège, Belgium; "Coal Cleaning Problems of Today," Dr. Karl Glinz, Berlin, Germany; "The Rational Cleaning of Coal," Dr. R. Lessing, London, England; "Gas Purification in Relation to Coal Sulphur," Dr. F. W. Speer, Jr., director of research, Mellon Institute, Pittsburgh, Pa.; "The Reason for the Need of Clean Coal," F. R. Wadleigh, consulting fuels engineer, Consolidated Gas Company of New York; title later, James B. Morrow, Pittsburgh Coal Company.

The men engaged in the transportation of explosives should be experienced and reliable

SAFE TRANSPORTATION *of* EXPLOSIVES UNDERGROUND

By F. J. BYRNE *

Strict Adherence To Rule Of Never Handling Explosives And Detonators At Same Time Fundamental Safety Principle—Summary Of Approved Safety Practices And Description Of Character And Uses Of Certain Facilities Contributing To Safety

IN a general discussion of the subject of the safe transportation of explosives underground there must be recognition of the fact that state mining laws differ and that mine conditions vary widely.

Therefore, no one system of handling explosives could be uniformly applicable in even a considerable percentage of cases. Besides, in this article, distinction is not made between coal mining and metal mining, except in certain instances where the data at hand deal with particular situations.

However, of basic importance in any type of mine is inviolable adherence to the rule of never handling explosives and detonators at the same time. This is so vital a consideration that any deviation violates a fundamental safety principle and positively nullifies every other precautionary measure ever evolved for the safeguarding of life and property.

Among other obvious precautions are prohibition of smoking, the keeping away of open lights and the avoidance of the carelessness in handling which sometimes results from long familiarity with explosives and detonators.

Of equal importance is the maintaining at the absolute minimum the quantity of explosives taken into a mine at one time and, likewise, the amount stored underground, even when in a suitable magazine.

Fortunately, the safety measures mentioned are well understood in the mining industry, both by operators and miners, and are usually observed. Largely as a result of the cooperation of owners and employes, accidents in handling explosives are very rare.

Obviously, the two factors involved in the transportation of explosives are the men engaged and the available facilities. That the men selected should be experienced and reliable goes without saying. Yet the care taken in choosing the right men can, of course, be offset by depending solely on the human equation with the possibility of a slip in judgment at a vital time. For that reason it is highly desirable that full advantage be taken of such equipment as experience shows makes the handling of explosives nearly as fool-proof as possible.

While possibly little or anything will be added by this article to the sum total of knowledge on the subject under consideration, effort will be made to present more or less of a summary or composite of various approved safety practices and to describe the character and uses of certain facilities which have contributed to the safety factor.

Taking for granted that the surface storage facilities are adequate from the safety standpoint, the next thing to do is to trace the movement of explosives from the magazine through the various stages of handling up to the point where the shot is ready to be fired. As explosives and detonators should not be transported together, it might be well to divide the subject accordingly and to separately consider the handling of caps and dynamite.

Especially interesting is the method of handling electric blasting caps in a leather sack, somewhat resembling a brief case, which is provided with a removable canvas belt with a series of separate pockets, each holding one cap. These belts vary in capacity, the number of compartments being 50, 75, or 100, according to the number of caps to be carried.

When folded, a single belt fits snugly into the case with the caps in vertical position and the loop wires extending slightly from the pockets. The sack has a wide flap which is held down by a clasp and locked. It is carried by means of a shoulder strap to permit the free use of the hands.

In a large eastern mine where detonators are carried in the type of sack described, the caps are taken into the workings by a shot-firer and, therefore, no cap is ever near powder until the loading of a hole is done.

The method of issuing detonators provides another safeguard, as the sack with the required number of caps is placed in a locked compartment in the distributing magazine, to which the shot-firer holds the key. This key is numbered to correspond with the number of the sack and is used to lock and unlock the sack. Under this arrangement each shot-firer has a separate locked compartment to which neither the miner nor any other shot-firer has access. At the end of a shift the sack is returned to its compartment together with a check for each cap used. A magazine distributor refills the belt in the sack each day and locks it in the shot-firer's compartment. The distributor also makes a record of the number of electric blasting caps used for a shift and the number of shots fired.

In mines where all shooting is done at night, a good practice is to have a man use a bag to carry the required number of cartridges for a shot to the working face, while the shot-firer follows later with the electric blasting caps. The shot-firer makes up the charge, tamps and fires the shot.

Another method followed in certain eastern coal fields is that of the shot-firer carrying the electric blasting caps, the lead wires and the tamper, leaving the helper to carry the explosive in a bag and the blasting machine. The shot-firer

* Institute of Makers of Explosives.

makes up the charge and the helper does the tamping.

Both of the practices described are considered safe and are rigidly followed.

In some other mines the miners purchase the explosive directly, but nothing else. In such cases the detonators are obtained by the shot-firers and are carried by them into the mines. When firing a shot, the shot-firer receives from the miner a brass check with the miner's number on it. The check has a money value to the shot-firer as it represents a fixed sum which has been deducted from the miner's pay. This also is a safe practice for the purpose of keeping caps and powder separated until ready to be shot.

In the matter of taking explosives into the mines and the subsequent handling of explosives underground, practices vary according to the provisions of state laws, insurance regulations, and other considerations. However, it is hardly necessary to remind that the maximum of care should be observed regardless of any leeway which might be taken advantage of under legal or other provisions.

When explosives are delivered at a shaft they should be guarded against danger of sparks from locomotives or from other sources. Also, the explosives should be covered, when necessary, to protect them from rain or other water. Attention should be given to piling cases so as to avoid danger of toppling and to protect them from anything falling on them.

The practice of not carrying explosives in cages on "man trips" is highly commendable, as is also the notifying of the engineer that explosives are to be lowered, in order that the skip or cage may be made to travel at a safe speed. Further, open lights on a cage carrying explosives should be banned.

When unloaded from the cage, explosives should be placed where there is no danger of being hit by cars or struck in any other way. Care should be taken not to deposit them where they will be under live electric wires or come in contact with rails through which electric current is returned. Keeping them at a safe distance from electrically operated mine equipment of every sort is also essential to safety. This is recognized to such an extent in Ohio that the law forbids the taking of explosives into an electrically equipped mine except at night.

Men unloading explosives on landings where there are no electric lights should exercise care in hanging their lights where there is no possibility of the lights or sparks falling on the explosives.

When transporting explosives in mine cars from the outside into drift mines the cases or kegs should be firmly fixed to prevent sliding or other movements. If possible, the cars should be drawn by mules or pushed to permit the turning off of current from trolley wires. Electric arcs caused by defective bonding of rails and the possibility of a trolley wire falling are always potential sources of danger. In short, any possibility of an electric current passing through explosives must absolutely be avoided.

Where, owing to the distance, it is not practicable to transport explosives by other means than electric haulage, closed cars should be used and the bodies thoroughly insulated. To provide the necessary insulation, heavy glass insulators to support the car body are used, or a heavy rubber mat is placed on floor.

No open lights should be permitted on the powder car and only the locomotive operator and his helper should travel on the train. Enough cars should be placed between the electric locomotive and the powder car to make certain that no sparks from the trolley wheel or wire fall on the car containing explosives.

Where it is necessary to climb ladders into stopes, subdrifts and raises, the men should have free use of their hands. That usually requires pulling explosives up by means of a rope or carrying them in sacks on their backs. When using a rope the greatest care should be taken to make certain that the container is securely fastened to the rope. If two men handle a package of explosives, it is advisable that the man below does not go up the ladder except to free the case in event it is caught on a projection or otherwise stuck. Carrying explosives up a ladder, either in a man's arms or in a sack slung from the shoulders, is not recommended, partly because it is an awkward way to handle them. Naturally, there is present the danger of slipping or dropping the container when carried under the arm and but one hand is free to grasp the rungs of the ladder.

What many believe to be the best way to take explosives up a ladder is to carry the cartridges loose in a sack. But, it is agreed, the sack should be specially constructed and be of strong material. The use of gunnysacks or cement bags presents numerous objections, among which is liability of tearing, which is increased if the bags are partly rotted, due to contact with water, especially that of mines where the water is more or less acid.

An approved type of sack is waterproof and, besides having shoulder straps, has a flap and is fitted with a strap and buckle. These sacks are rubberized and are of various sizes to adapt them to use according to the conditions met.

The claim that "accidents do not *happen*—they are *caused*"—has peculiar application to mine accidents due to the handling of explosives. Therefore, the logical course is to avoid the cause. This, in the last analysis, is the beginning and the end of accident prevention of every character.

SULPHUR PROBLEM IN BURNING COAL

The clinkering of the ash in a furnace does not always vary directly with the sulphur content of the coal, states J. F. Barkley, in Technical Paper 436, recently issued by the United States Bureau of Mines, Department of Commerce. In common practice the sulphur content has been used as an index of clinkering tendencies. When sulphur occurs in the coal as a component of iron pyrites it indexes to a great extent the amount of the effective base, iron. When no iron is present there generally exists a highly siliceous ash of high-fusion temperature. When much iron is present the silica-base ratio is apt to be such that an ash of low-fusion temperature occurs. At times in fuel beds, because of lack of oxygen, the iron is oxidized to ferrous oxide, which forms with silica ferrous silicates that have a relatively low-fusion temperature.

A discussion of the sulphur problem in burning coal is given in Bureau of Mines Technical Paper 436, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of 5 cents.

SWELLING OF COAL DURING COKING

It is common knowledge that the semibituminous coals give trouble from sticking of the coke in the retort or oven after carbonizing. This is probably because the cokes do not shrink appreciably during the latter stages of carbonization, as do those from coals higher in volatile matter. Experiments at the Bureau of Mines' Pittsburgh Experiment Station have shown, however, that even semibituminous coals can be made to swell when coked at extremely rapid rates as in the crucible coking test. If the temperature is raised to 900° C. in one minute a strongly swollen button will result, whereas with the higher volatile coals swelling is not so pronounced. Results of the crucible test, it should be pointed out, should not be taken as indicative of the ease with which coke made from it can be pushed out of the oven, since, although they do show abnormal swelling with coals which stick in the retort, the sticking is due rather to failure to shrink than to swelling during coke formation. Swelling with semibituminous coals is not observed with normal coking rates.

THE COLSTRIP OPERATION IN MONTANA

By F. R. Wadleigh *

A Description of the Strip Mining Operation of the Northern Pacific Railroad in Rosebud County, Montana—History of Development and Cost of Mining Outlined.

THE four states of Montana, North Dakota, South Dakota, and Wyoming contain what has been described as the greatest coal deposit in this country, if not in the world.

According to the estimates of M. R. Campbell, chief geologist, United States Geological Survey (given in an address before the International Coal Conference

at the Carnegie Institute of Technology in 1926), these states had original coal (including lignite) reserves of 1,653,127,000,000 tons, or about 48 percent of the total original reserves (including anthracite) in the entire United States.

The actual figures, as given by Mr. Campbell, are as follows:

	Lignite	Sub-bituminous coal	Bituminous coal	All coal and lignite
Montana	315,474,000,000	62,985,000,000	2,655,000,000	381,384,000,000
North Dakota ..	600,000,000,000	....	....	600,000,000,000
South Dakota ..	1,020,000,000	....	....	1,020,000,000
Wyoming	....	590,160,000,000	80,563,000,000	670,723,000,000
Total	916,494,000,000	653,145,000,000	83,218,000,000	1,653,127,000,000

Total U. S. original reserves, 3,444,552,000,000.

Taking Montana alone, Mr. Campbell's estimate shows that the state contained originally about as much coal as did our three largest producing states (1927), West Virginia, Pennsylvania, and Kentucky; the estimate being 388,019,000,000 tons for the three, as against 381,384,000,000 tons in Montana. And it should be pointed out that, at the close of 1925, while 10,503,000,000 tons had been produced in Pennsylvania, West Virginia, and Kentucky, but 81,051,165 tons had been produced in Montana, which would give the three eastern states reserves of 377,516,000,000 tons, against 381,302,000,000 tons in Montana.

It is impossible, of course, for anyone to visualize what such tremendous figures mean, but they are given to show the vast extent of Montana's coal deposits, compared with those of other states. We must remember, however, that coals of the three eastern states mentioned are of much higher quality than those of Montana, so that they can not be compared, ton for ton, as regards heating value; the average B. t. u. value for the Montana coals will probably be 25 to 30 percent lower than the average for the eastern coals.

It is quite fitting that there should be located in the world's greatest coal deposit what is potentially the greatest coal-producing plant in the country, if not in the world; not in terms of actual output today, although this is large (now at the rate of 1,000,000 tons per year), but in the tonnage of coal in actual, visible sight, under development, as well as in production possibilities. This operation is at Colstrip, in Rosebud County, Mont., about 30 miles south of Nichols, on the Northern Pacific Railroad main line.

And it is worth noting that the man whose foresight, energy, and persistence were mainly responsible for bringing about the Colstrip development, H. E. Stevens, chief engineer of the Northern Pacific Railroad, is not a mining engineer, nor has his work been especially concerned with coal or its use; his entire experience has been in railway construction and maintenance.

A brief story of the Colstrip development brings out some interesting features as to its origin, its evolution, and its future possibilities, not only in further production development but also in the use of coal of the character produced.

Source of Data

In Eugene McAuliffe's book, "Railway Fuel," there is a brief description of the Rosebud coal, with extracts from a report by M. A. Daly, fuel supervisor, Northern Pacific Railroad, giving the results of tests made on the Northern Pacific locomotives. The United States Geological Survey issued, under date of March 21, 1924, a preliminary statement in the shape of a press release, which gave a brief description of the Rosebud bed in Montana and its geology.

All of these articles and reports were written before the operations of the Northern Pacific at Colstrip were well under way, and do not bring out the character, extent, and importance of the Colstrip development.

The hearings before the Interstate Commerce Commission on the proposed merger between the Northern Pacific Railroad and the Great Northern Railroad made public much detailed information regarding the Rosebud coal, its production at Colstrip and its use, as the proposed use of coal from there made up a considerable item in the estimated savings to be brought about by the proposed merger, under which is contemplated the use of a large tonnage of Rosebud coal by the consolidated roads, amounting to about 3,000,000 tons annually.

It was in connection with the merger that the writer visited Colstrip and was given the opportunity of seeing the plant and its actual operation, and of obtaining first-hand data regarding the production and use of the coal, through the courtesy of H. E. Stevens, chief engineer of the Northern Pacific Railroad, and P. E. Thian, valuation engineer.

Forsyth, Mont., Coal Field

The Forsyth field, in which the Colstrip development is located, was examined by a party of the United States Geological Survey and a preliminary statement was issued by the survey, under date of March 21, 1924. Part of the following data is taken from that report and from later information issued by the survey.

Coal Beds

The Rosebud bed, which is the most important coal bed of this field, belongs to the Tongue River member of the Fort Union formation, which here consists of about 1,650 ft. of clays, sandstones, and coal beds.

* Consulting Fuel Engineer, Consolidated Gas Company, New York City.

The Rosebud bed is exposed at only a few places, but it is easily traced by the heavy reddish clinker formed by the burning of the coal at its outcrop.

Nearly all of the coals in this general region have burned along the outcrop and under cover until the fire was smothered by the weight of the overlying material caving in. (Smith.)

The Rosebud coal is of sub-bituminous rank; it has a conchoidal fracture and freshly exposed surfaces are shiny-black, which becomes dull on exposure to the air. The coal slacks quickly, a characteristic common to the lignite and sub-bituminous coals of the Middle West.

My own observation of the Rosebud coal, however, leads me to conclude that the Rosebud coal does not slack so quickly as other coal of the same rank.

At 70 degrees F. a 4-in. lump will crumble to pieces in 24 hours; at 55 degrees F. the same lump will last a week; at 40 degrees F. lumps of coal will remain hard and black for five weeks. In contradiction to this, two 4-in. lumps, shipped from Colstrip to New York, have been exposed for about four weeks to temperatures ranging from 65 to 70 degrees F. and still retain their size, with only a slight degree of decrepitation.

The McKay bed, which lies from 6 to 30 ft. below the Rosebud, is considered a split of the latter; it ranges from 6 to 10 ft. in thickness and the coal is of a similar character to that from the Rosebud bed. Up to this time it has not been mined.

History of Development

In 1913, as part of a plan for prospecting the coal resources tributary to its lines, the Northern Pacific Railroad had a geological examination made of the coal in Rosebud County, Mont., where the Rosebud seam was known to outcrop and to underly a large area.

The examination resulted in an estimate that the Rosebud seam underlaid an area of approximately 700 square miles in Montana alone, and that the full thickness of the seam averaged about 28 ft., except where crowded or burned out. It was estimated also from the outcrop prospecting that there were at least 32,100,000,000 tons of Rosebud seam coal in Montana alone, and that the area of the Rosebud seam lying within the Northern Pacific land grant, 946 square miles, contained approximately 11,550,000,000 tons. Of this area, the Northern Pacific still retains mineral rights on approximately 316 square miles, which, it was estimated, contained about 3,860,000,000 tons of Rosebud coal; this was in addition to the coal in the McKay seam underlying the Rosebud.

In 1917, Mr. Stevens, chief engineer of the Northern Pacific, was instructed to make a detailed survey for the purpose of determining the best point for the location and entry of a railway line into the field. The general characteristics of the coal were to be determined and its suitability for use as locomotive fuel, as well as the mining methods to be used and the probable cost of the coal at mine and at points of consumption.

After decision was made as to the best location for the branch from the Northern Pacific main line, a complete survey was undertaken of 15 square miles underlain by Rosebud coal, in the center of which is the present operation. Over 200 drill holes were put down through the Rosebud seam and five test shafts, and it was estimated, as a result of the examination, that there were in the 15 square miles a stripping tonnage of Rosebud coal with 40 ft. or less of overburden, amounting to approximately 43,000,000 tons; between 40 and 100 ft. overburden, 107,000,000 tons, and with an overburden greater than 100 ft., approximately 180,000,000 tons, or a total tonnage in the 15 square miles of 330,000,000 tons.

Another tonnage estimate, made independently, by a well-known mining engineer is as follows. This includes both the Rosebud and McKay beds:

In the 15 square miles—	
Under 50 ft. cover	Net tons
Rosebed bed	81,000,000
McKay bed (8 ft.)	19,000,000
Total	100,000,000
50 to 75 ft. cover	
Rosebud bed	115,000,000
McKay bed	33,000,000
Total	148,000,000
100 ft. cover and over	
Rosebud bed	160,000,000
McKay bed	46,000,000
Total	206,000,000
Grand total	454,000,000

The construction of a railroad from the main line along Armells Creek was finally undertaken, with the opening of a stripping operation about 30 miles directly south of Forsyth, Mont.

For future development, it was reckoned that there could be opened in the 15 square miles mentioned at least four stripping pits, each containing approximately 6,500,000 tons.

It should be mentioned here that it was found necessary, in order to make a continuous operation, to lease certain sections from the Federal Government as to mining rights. The present lease from the Government covers an area of 2,428 acres, on which a royalty of 10 cents per ton is paid.

Actual development of the field was not begun until early in 1923, and the railroad branch was finally completed in December, 1923. At that time a test pit was opened and 50,000 tons of coal were taken out and used for general test purposes. Afterwards, development of the stripping operation proceeded.

As the Northern Pacific Railroad and its subsidiary, the Northwestern Improvement Company, which operates its coal properties, were not equipped to handle a large stripping development, the entire work of development and production was let by contract, after bids had been submitted to Foley Brothers, Inc., St. Paul, Minn., who are still doing the work under a five-year contract. Under this contract the contractor was given the entire selection of equipment for handling the desired output.

Cost of Mining

After taking into consideration all factors, it was estimated by Mr. Stevens that the cost of producing 6,500,000 tons of coal was equivalent to 88 cents per ton on cars at Colstrip, and that Rosebud coal could be put on cars at a price not exceeding that figure for an indefinite period. It is but fair to say that this estimate of cost was disputed at the Interstate Commerce Commission hearings, Charles H. Smith stating that he considered it conservative for coal under 50 ft. cover, but too low for cover exceeding 50 ft. The actual cost per ton for 1926 was given by Mr. Stevens as 98 cents, on an output of 730,000 tons.

Use Developments of Rosebud Coal

The successful use of Rosebud coal on locomotives may properly be considered as an important step toward the more extended use of the low-grade coals and lignites of the western fields. To have found satisfactory methods and equipment for its successful use is an exceedingly valuable development and widens considerably the utilization field for coals of similar character. Those responsible for the origin and carrying out of the whole plan deserve great credit for the foresightedness, persistence, and ability shown in developing the present output of Rosebud coal and for the results obtained from its use.

In the fall of 1924, the regular use of Rosebud coal began on freight locomotives in the first district of the Montana division, between Laurel and Livingston, a distance of 100 miles. In 1925, its use was extended to include all main line freight locomotives between Mandan, N. Dak., and Missoula, Mont., a distance of 800 miles.

Beginning in December, 1927, the use of Rosebud coal was further extended to the entire main line between Dilworth, N. Dak., and Spokane, Wash., a distance of 1,257 miles.

But before any extended use of Rose-

bud coal could be effected, it was necessary, owing to its different character from that of the coals then in use, to make a series of tests and experiments in order to determine what changes, if any, should be made in locomotive equipment, methods of handling, etc., so as to bring about successful use.

The results of these tests are described in the following paragraphs:

In 1918, about one year after actual prospecting had been started, 374 tons of Rosebud coal were taken out of a test shaft and hauled by automobile truck to the Northern Pacific main line. Thorough tests were made on locomotives, which showed that the coal could be successfully used. These tests ("Railway Fuel," pages 46-52) developed the fact that, in order to use the coal to the best advantage, it was necessary to make certain alterations in the grates and in the locomotive front end arrangement; the latter was a mere matter of draft adjustment; but the grate alterations resulted in an entire change in the shape and amount of openings. As described by Mr. Daly, standard Northern Pacific grates had slotted openings ¾ in. wide with a total opening of 39.14 percent. The grate finally chosen, as a result of numerous experiments, had round hole openings ½ in. in diameter with openings of 12.19 percent.

These changes were made for two reasons.

(1) To lessen the tearing effect of the draft on the fuel bed.

(2) To minimize ashpan losses.

It was also found that the "Rosebud" grate was not only successful in burning Rosebud coal but that other kinds of coal could be used with equal facility, and that, in comparison with the standard Northern Pacific Railroad grate, its use gave the following advantages with all coals:

(a) Elimination of tearing effect on fire.

(b) Reduction of ashpan loss.

(c) Reduced maintenance.

(d) Better steaming of locomotives and reduced steam failures.

(e) Greater ease in maintaining fires, without cleaning.

Regarding the Rosebud grate, Eugene McAuliffe makes the following comments ("Railway Fuel," page 51):

"The spark-throwing characteristics of lignite and sub-bituminous coal seem to be very much modified by the use of this grate, designed, as it is, to furnish a restricted but widely distributed area for the admission of air. With the finely divided air openings, the fire bed is maintained very thin and it is not uncommon to find the fire to be less than 2 in. thick, suggesting that the smaller particles of coal are consumed in suspension, as is the case when pulverized coal is burned in stationary plant boilers."

Mr. McAuliffe's comments are confirmed by my own observation, as to spark-throwing and thickness of fire, on one of the Northern Pacific Railroad locomotives.

I have given considerable space to the development of the Rosebud grate, partly because it was a logical step from the development of the Rosebud coal operation and partly because it points to greater possibilities in the successful use of the lignite and sub-bituminous coals.

No ash-fusing temperature determinations have been made of Rosebud coal, as far as can be learned, but tests and the extended use of the coal have proved that it makes a comparatively small amount of clinker and that the clinker is soft and does not adhere to the grates.

To this characteristic may be attributed much of the success which has attended its use, particularly in the lengthening of locomotive runs, in conjunction with the use of the Rosebud grate, described elsewhere.

	Net tons of coal used	Total cost of coal used	Cost per net ton	Pounds of coal used per 1,000 gross ton-miles in freight service	Pounds of coal per passenger train cost mile
Northern Pacific R. R ...	182,883	$535,240	$2.93	186	22.2
Great Northern R. R.....	97,559	415,601	4.26	177	18.5

Analyses and Tests

The following analyses of Rosebud bed coal are from various sources, as given:

1. Average of 59 samples

Moisture, air-dried basis........	10.56
Volatile matter, air-dried basis..	31.34
Fixed carbon, air-dried basis.....	50.36
Ash, air-dried basis.............	7.91
Sulphur, air-dried basis........	0.64
B. t. u., air-dried basis..........	10,915

2. Average of a number of samples, U. S. Bureau of Mines, 7.73 percent air-drying loss

Moisture	16.80
Volatile matter	31.70
Fixed carbon	43.67
Ash	7.8
Sulphur	0.7
B. t. u.........................	10,283

3. Other analyses, as received basis

Moisture	25.2	24.8
Volatile matter	26.5	28.7
Fixed carbon	40.6	38.8
Ash	7.7	0.7
Sulphur	0.7	0.7
B. t. u...................	9,040	8,900
Sp. gr.	1.304	1.30

4. Average of 11 samples taken from locomotive tender, as reported by Mr. M. A. Daly

Loss on air drying......	19.15 percent
Moisture	8.70 percent
Volatile matter	35.10 percent
Fixed carbon	45.95 percent
Ash	10.25 percent
Sulphur	0.61 percent
B. t. u.................	10.410 percent

5. Rosebud coal, as received, "Railway Fuel," E. McAuliffe

Moisture	25.80
Volatile matter	28.50
Fixed carbon....................	37.13
Ash	8.57
B. t. u.........................	8,487

6. Average of 48 samples from prospecting shafts and bore holes, Northern Pacific Railroad

Loss from air drying...........	12.30
Retained moisture..............	11.08
Volatile	29.94
Fixed carbon....................	51.20
Ash	7.77
Sulphur	0.67
B. t. u.........................	10,825

Savings from Use of Rosebud Coal

It was estimated by Mr. Stevens, and so stated in his testimony at the Interstate Commerce Commission hearing, that in 1926, substitution of Rosebud coal for coals previously used showed a saving of $700,000, which would, of course, be proportionately increased by the use of a larger tonnage on the Northern Pacific locomotives; it was estimated that over 1,000,000 tons will be used in 1928.

As of interest in this connection, the above figures are given from the Interstate Commerce Commission reports for December, 1927.

Production of Rosebud Coal at Colstrip

No production figures are available except those for the years 1926 and 1927, as follows:

	Total production
1926.................	730,677 net tons
1927.................	822,114 net tons

For 1928, it is estimated by the Northern Pacific that approximately 1,000,000 tons will be produced.

It is of interest, in this connection, to consider the estimated output as proposed in the plans for merging the Northern Pacific and the Great Northern Railroad.

In the public hearings before the Interstate Commerce Commission, it was testified that the merged roads would, under the plans proposed, use about 3,000,000 tons of Rosebud coal yearly.

At present, the stripping operation at Colstrip is confined to one pit, which is about 7,800 ft. long and is being cut 900 ft. wide.

Up to September 1, 1927, there had been removed from this pit about 1,778,000 tons. It was originally estimated that the pit contained about 6,500,000 tons of coal and that on January 1, 1928,

there still remained about 4,500,000 tons to be taken out.

Other pits of similar area have been tentatively located for future production requirements.

The Colstrip Operation

The Colstrip operation is not a mine but an excavation or stripping. A seam of solid coal, with an average thickness of 28 ft., has been so deposited that the overlying earth and rocks can be removed by mechanical means and the coal loaded into cars, ready for shipment, at an extremely low cost and with a minimum of labor, a force of 71 men producing about 1,000,000 tons of coal per year. Is there any other coal operation in the world that can show a like performance or one approaching it? For the year 1926, the U. S. Bureau of Mines' official statement gave the following figures for this operation:

Loaded at mines for shipment	Value per ton	No. of days worked
729,653 net tons....	$1.50	216

No. of men employed	Average tons per man employed per day
71	47.64

Compare the output per man per day at this operation with the maximum in other producing states in 1926—it ranges from 29.88 in Colorado to 2.50 in South Dakota. The following table, taken from the Bureau of Mines report, gives the highest average production per man, by counties in each state, in 1926:

State	County	Average tons per man per day
Alabama	St. Clair	3.59
Arkansas	Franklin	3.72
Colorado	Routt	29.88
Illinois	Jackson	9.03
Indiana	Pike	8.35
Iowa	Dallas	3.29
Kansas	Cherokee	6.16
Kentucky	Martin	6.87
Maryland	Garrett	4.09
Michigan	Saginaw	2.63
Missouri	Barton	8.21
Montana	Rosebud	47.64
New Mexico	Colfax	4.43
North Dakota	Burke	12.08
Ohio	Harrison	8.12
Oklahoma	Various	3.94
Pennsylvania	Greene	5.34
South Dakota	Perkins	2.50
Tennessee	Clairborne	4.93
Texas	Various	4.22
Utah	Emery	7.07
Virginia	Lee	4.79
Washington	Various	5.50
West Virginia	Logan	6.12
Wyoming	Sheridan	10.48

Equipment at Colstrip

The stripping equipment at Colstrip consists of the following:

One 350-ton Marion revolving type combination drag line and shovel, equipped with 150 ft. drag line boom and a 90-yd. boom, both with 6-yd. dippers.

One 175-ton Bucyrus revolving type shovel with a 75-ft. boom and 7-yd. dipper.

One Paige gasoline drag line with 80-ft. boom and 2½-yd. bucket.

Twenty-ton locomotive crane, compressors and drilling machine.

Two 60-ton electric storage battery locomotives, used for shifting and placing cars; designed specially for this work by the General Electric Company.

There is also a well-equipped machine shop and storage room; tools are all motor-driven. The camp is well laid out and contains 10 buildings for various purposes, including a recreation hall, two bunkhouses, and 14 cottages—all electrically lighted and steam heated from a central boiler plant.

All machinery is electrically operated, power being obtained from the Montana Power Company.

Stripping Operation

The pit now being worked is about 7,800 ft. in length and is being cut to a width of 900 ft.

The pit was opened by cutting the Marion shovel as a drag line, taking out a through cut about 125 ft. in width, on the bottom for the entire length of the pit. The Bucyrus machine is used as a coal loader and follows the stripping work, on the bottom of the coal seam; the track for cars to be loaded is laid on top of the seam, as shown in the photographs.

The output of the stripping shovel has been quite uniform for the different classes of material, so that, with cross sections and boring data available, the location of the stripper at any time can be predicted with considerable accuracy and each of the two machines arranged to meet the fuel requirements of the railway company.

At the time of the writer's visit to Colstrip, about 550,000 tons of coal had been stripped and was ready for the loading shovel.

Preparation of Coal

It has not been found necessary to give any cleaning or screening preparation to the Rosebud coal, except such as is customary at the various locomotive coaling stations. Coal is loaded by the electrically-operated shovel directly into railroad cars, which are then hauled to the coaling stations and unloaded.

Future of the Sub-bituminous Coals and Lignites

There seems to be important possibilities for the future of the low temperature carbonization of the Rosebud and coals of similar character, and experiments are now being conducted to determine their value for such treatment. A great deal of experimental work has already been done by the U. S. Bureau of Mines and the University of North Dakota on the carbonization, briquetting and uses of the low-grade coals and lignites of the Dakotas, Wyoming, and Montana. Much of this work has been described in various bulletins of the bureau, of which the following is a partial list: Reports of Investigations — Serial 2441, February, 1923; Reports of Investigations—Serial 2569, February, 1924; Bulletin 89; Bulletin 255; Bulletin 221; Technical Paper 207.

Much work on lignite utilization has been done by the Canada Department of Mines, the results of which are available in various bulletins of the department.

In Germany, France, Italy, and notably in Australia the use development of the low-grade coals and lignites has been and is now the subject of a great deal of investigation and research. In Germany, the use of "brown coal" (lignite) has progressed to such a point that its production in 1926 amounted to 139,877,000 metric tons, of which 34,354,000 tons were converted into briquettes.

With the practically inexhaustible supply of cheaply available coal along its lines in Montana, one may visualize a day when the Northern Pacific Railroad will be operated with electrical power made from Montana coal, at plants near its own mines, supplied with water from the Yellowstone River; perhaps with by-product recovery, and the manufacture of briquettes from a carbonized product, for house heating and farm use.

A logical development this would be, waiting only on the country's growth in population and progress; such growth would be effectively carried on by such a use of the country's greatest natural resource.

KENTUCKY GEOLOGICAL SURVEY REPORT

The Administrative Report for the (Sixth) Geological Survey of Kentucky for the years 1926 and 1927 shows that during the biennium of 1926-27 50 counties were surveyed in the State of Kentucky, totaling 16,659.15 square miles, or about 40 percent of the area of this state. During the same time 15 new sheets and part sheets of 1: 62,500 scale topography were surveyed.

There are available now from the survey 35 separate oil and gas structural maps covering the entire eastern Kentucky coal fields, involving an area of about 10,500 square miles. Most of this is mapped on a unit key-bed, the Fire Clay coal (No. 4 Hazard field—Pottsville). It is the largest single area thus mapped in the world.

Figures showing production of Kentucky's minerals summarized for 1925 and 1926 and given in detail for various years with graphs including 1927 are presented.

A descriptive list of 70 reports and 302 maps now available is given.

EXPLOSIVES AND THEIR PROPERTIES

(Continued from page 776)

It was known long ago that the diameter of the cartridge is of great importance in this respect. Our Federal Bureau of Mines showed it recently in a great number of tests. The rate of detonation rises rapidly from ⅞-in. cartridges to 1¼ in., and very slowly to 1½ in. In one series of shots ⅞-in. cartridges gave 1,900 meters per second, the 1¼-in., 5,120, and the 1½-in., 5,330 meters per second, for 40 percent gelatin dynamite. In another series from 2,630 meters per second for ⅞-in. to 3,445 meters per second for 1¼-in., and 3,750 for 1½-in.—this on 40 percent strength L F ammonia powder.

Explosion by Influence

It is required of explosives that they should communicate the explosion from cartridge to cartridge, even with a space left between them. It is not necessary to assume that it is due to the effect of the flame jumping the distance between the cartridges, because it is possible to explode dynamites by influence even when there is noncombustible substance intervening.

Should the medium between cartridges be air, it is possible to calculate the temperature rise according to the law of adiabatic compression:

$$T \text{ equals } T' \left\{\frac{P}{P'}\right\}^{\frac{k-1}{k}}$$

Where T' is absolute temperature and P' is the pressure before beginning of compression, T is the absolute temperature and P the maximum pressure reached, k is the ratio of specific heats at constant pressure to constant volume (k equals 1.4 for air). We calculate that under a pressure of only 200 atmospheres, or 2,845 pounds per square inch, the air will be heated to 1,062 degrees C. or 1,944 degrees F. The pressures developed in a borehole are much higher. The Federal Bureau of Mines gives the following figures:

	Lbs. per sq. in.
60% straight dynamite (nitroglycerin)	146,670
50% straight dynamite (nitroglycerin)	132,300
40% ammonia dynamite	126,890
30% straight nitroglycerin dynamite	126,230
40% straight nitroglycerin dynamite	121,030
40% gelatin dynamite	120,110

Sensitiveness to explosion by influence depends much on the diameter of the cartridge. It is lowest for ⅞ in. and rises with the diameter. Our Federal Bureau of Mines gives the following results of its experiment:

Forty percent gelatin, one month old, failed to explode.
At 9 to 12 in. for ⅞-in. cartridge.
At 30 to 35 in. for 1½-in. cartridge.

The six months' old gelatin dynamite failed to explode.
At 0 to 6 in. for ⅞-in. cartridge.
At 25 in. for 1½-in. cartridge.

Forty percent L. F. ammonia dynamite, one month old, failed to explode.
At 18 to 35 in. for ⅞-in. cartridge.
At 50 to 70 in. for 1½-in. cartridge.

The six months' old 40 percent L. F. ammonia dynamite failed to explode.
At 10 to 15 in. for ⅞-in. cartridge.
At 30 to 70 in. for 1½-in. cartridge.

The fineness of ingredients exert a considerable influence on the sensitiveness of explosives, a fact borne out by every-day experience in powder manufacture. Also the strength of detonator used, the nature of the ground on which the shooting is done, and the strength of confining media are of importance as far as sensitiveness of detonation by influence is concerned. This should be borne in mind, especially when the powder is judged by the determinations of sensitiveness made on the ground. There are many powders, especially in Europe, that possess no sensitiveness when shot on the ground in paper tubes—and detonate completely in the borehole.

We have attempted to get an analysis of the many sides of explosives' action. The question now is: Presume we have information as to what are the gases given off during explosion—we can tell what the pressure is, the temperature, the rate of detonation, etc.—then how are we to consolidate this information into an opinion as to what the ultimate effect, the actual performance of the explosive in a mine or quarry, etc., might be? This was a very much debated question among explosives men. The opinions now seem to be somewhat in agreement as to the theoretical treatment of the subject. We hope we made it clear that data as to composition, heat evolved, and maximum temperature of explosion, are consolidated into a figure expressing the pressure (f) produced in the borehole. We have attempted to show that the rate of detonation may determine either the usefulness or uselessness of a mixture of carbon carriers and oxygen carriers. It was also shown what far-reaching effect the charge density has.

A German investigator, Kast, has shown that should the pressure exercised by one unit of explosive, confined in a unit volume (density equals 1), which we shall term as f, times the loading density, d, times the rate of detonation, V, gives a number expressing the measure of total usefulness of an explosive (Brisanz):

Then B equals f x d x V.

He obtained in this way the following figures:

Nitroglycerin (loading density)	1.60	145,900
Mercury fulminate (loading density)	3.50	125,800
100% blasting gelatin (loading density)	1.63	156,300
80% gelatin dynamite (loading density)	1.66	95,950
Trinitrotoluol (loading density)	1.59	85,100
75% Guhr dynamite (loading density)	1.50	75,800
Ammonium nitrate (loading density)	1.30	42,700
Black powder (loading density)	1.20	1,350

Using the same method, one can compute for—

40% straight NG dynamite (loading density)	1.24	40,600
40% gelatin dynamite (using 40% dynamite as primer) (loading density)	1.65	41,740
40% gelatin dynamite (using No. 6 blasting cap) (loading density)	1.65	19,235
40% ammonia dynamite (loading density)	1.57	28,160
Black blasting powder (loading density)	1.25	2,260

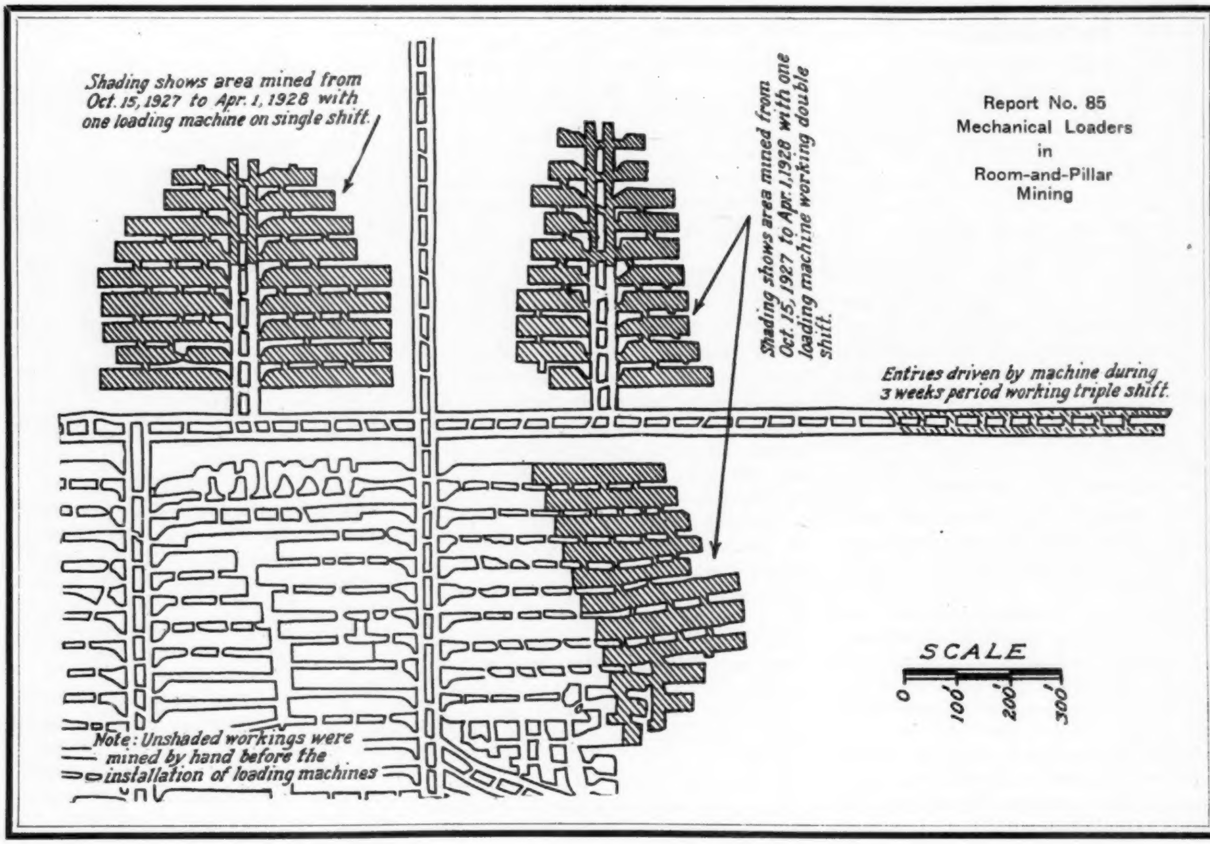
These numbers do show an interesting comparison between effective strengths in a fair concordance with the findings in practice. One must always assume, however, that the maximum rate of detonation is reached, that the detonation is complete, and that the powder fills the borehole completely.

It is hoped that the analysis of the many properties that go toward best and most complete utilization of potential power of explosives may invite a discussion from the powder consumers and lead to an intelligent cooperation between the powder man and the mining man.

SALES OF CLAY IN 1927

The quantity of clay sold by producers in the United States in 1927 amounted to 3,849,176 short tons, valued at $13,697,-159, or $3.56 a ton, according to a statement made public by the Bureau of Mines. These figures show a decrease of 3 percent in quantity and value, compared with 1926. They represent only clay sold as clay or mined under royalty and do not include the much greater quantity of clay that was burned into clay products by the producers themselves from their own property. The leading five states, in the order of the quantity of clay sold, were Pennsylvania with 23.3 percent of the total quantity, Missouri with 10.8 percent, Ohio with 8.4 California with 7.5 percent.

The imports and exports of clay decreased in quantity and value in 1927 as compared with 1926. The imports of clay amounted to 394,500 short tons, valued at $3,448,970, a decrease of 19 percent in quantity and value. Kaolin, or china clay, constituted 86 percent of the total imports in 1927. Exports of clay in 1927 amounted to 99,384 tons, valued at $1,117,889, an increase of 11 percent in quantity and 13 percent in value as compared with 1926.



MECHANIZATION REPORT NO. 85

By G. B. Southward

REPORT No. 85 describes a room-and-pillar mining operation with mechanical loaders in a 6½-ft. seam of coal. This mine was worked for a number of years with hand loading, but in October, 1927, two loading machines were installed and all hand mining discontinued. The map accompanying this report shows the actual mine workings in the section where the mechanical loaders were used; the unshaded portions show the extent of the hand mining prior to the installation of the machines, and the shaded portions show the entry and room work done with the loaders to April 1, 1928.

The map shows that the rooms in the last panel to the left were all driven from the entries and the rooms in the last panel to the right were advanced for a distance of about 300 ft. This was done from October 15, 1927, to April 1, 1928, with one loading machine working double shift. In the first panel to the left off the main entries the mining indicated by the shading was done by one loading machine on single shift during this same 6½ months period. In this panel the entries had already been driven by hand

MECHANICAL LOADERS IN ROOM-AND-PILLAR MINING

for a distance of about 300 ft. when the machines were installed but no room work had been started. In 6½ months the entries had been advanced 200 ft. to the panel limit; five rooms to the right and left were driven up and completed and four rooms on each side were more than half completed. This is equivalent to completing 15 rooms and at this rate it is estimated that a 20-room panel would be developed from the main entries and all rooms mined out in a nine months operating period.

In hand mining, a standard panel worked 19 rooms off of each side of the entries and about three years was the average time that a panel of this size would be developed and mined out. Since the area mined by the loading machine in 9 months is about one-half of the size of the hand-mining panel, an approximate comparison between the hand-loading and machine mining records indicates that the rate with machines is about twice as fast as with hand loading at this mine.

During a recent one-month operating period the average production for three loading machine operations was 615 tons per day or 205 tons for each machine shift in a panel. The average production from a panel with hand mining was from 200 to 250 tons per shift but a panel had twice the number of rooms under development as with mechanical loading. This means that with mechanized loading the mining territory is concentrated into slightly more than half of the area that would be required for the same tonnage with hand work. It has been found at this operation that the faster rate of mining and the concentration of working places has resulted in lower installation and operating cost for track, timbering and general maintenance in the entries and rooms.

In hand mining the rooms were driven 35 ft. wide and when the mechanical loaders were first installed this same width was maintained. A double track was laid in each room with a cross over between the two tracks and with connecting switches through the break-throughs

between adjoining rooms. It was thought that the two loading tracks would eliminate some of the delay incidental to shifting cars on a single track. However, when the loading machine was in position to load on one track it had to change its position to load onto the other and in a wide room the machine could not reach from one corner of the room to the track on the opposite side.

After using this system for some time it was decided that an improvement could be made by reducing the width of the rooms to 30 ft. and bringing the two tracks together at a point close to the face. This provides a single track for loading at the face and a side track for car shifting. The switch is moved ahead as the room advances so that the shifting distance for the cars is reduced to a minimum. Because of the short distance it is usually possible to drop an empty by hand to the machine while the load is being hauled and this adds a fraction of a minute to the operating time of the loading machine on each car placement. The small capacity of the mine cars requires that a comparatively large number must be loaded during a shift and a short time saved on each car becomes an appreciable saving during the course of an eight-hour shift.

The loading machine operations at this mine are considered by the management as satisfactory and successful and to have shown marked economies over hand mining. The management reports that from the time the machines were first installed they have had a very gratifying cooperation by the men employed on these operations and the efforts and interest shown by these men has been a very material factor toward their success.

OPERATING REPORT

Physical Conditions

The seam has an average height of 6½ ft. of hard structure coal with intermittent or occasional streaks of impurities. The top is a slate which stands fairly well in the entries and rooms. Hard clay bottom. Seam is generally level. Cover 250 ft. Open lights are used; the entries are rock dusted and sprinkled.

Mining System

Room-and-pillar advancing with mechanical loaders in the entries and rooms. Panels 550 ft. wide are developed by a pair of entries in the center and rooms are worked to the right and left. Ten rooms are worked advancing off each side and are driven 30 ft. wide on 50-ft. centers 250 ft. long. A new plan contemplates driving the rooms 500 ft. long.

One machine is used in a panel driving the rooms and advancing the entries. An average of between three and four rooms are loaded out each shift and four or five rooms are kept under development off each side of the entries in order to provide sufficient working places so that the loading, cutting, drilling and other operations may be carried on simultaneously and without interference during the working shift.

Cutting, Drilling and Blasting

The coal is undercut by machine with a 6-ft. cutter-bar and is drilled with an electric hand drill. Various types of powder with different shot spacings have been tried and the present method of shooting with permissible explosive has been found the most satisfactory and has increased the tonnage loaded by 20 percent. Eight shots are made in a room; four are first fired near the bottom of the seam to give a snubbing effect and these are followed by four top shots. The coal is well broken down by the shooting so that very little digging is required by the loading machine.

Two cutting machines, with a crew of two men each and two drilling crews of two men each do the cutting, drilling and shooting for three loading machine operations. This work is usually done on the day shift. At times there are some hard impurities in the seam and where this occurs an extra shift of cutting and drilling is necessary and is done at night. One shot firer does the shooting for the loading operations.

Loading

The loading machine has caterpillar trucks on which it works and travels from place to place and loads directly into mine cars. Each machine is operated by three men, one at the control, one at the head end and one at the loading boom who trims the cars and drops the empties from the sidetrack.

Two loading machines are operated at this mine, one working on day shift only and the other on both day and night shifts. This makes an equivalent of three mechanical operations.

Haulage

The track is of 16-lb. steel on 36-in. gauge in the room with a sidetrack as already described. All gathering haulage is done with mules. One driver hauls the loads from the machine to the room sidetrack and another driver with a "spike team" hauls trips of several cars to the main parting. The empty cars are dropped from the room sidetrack to the loading machine by hand except occasionally when an adverse grade may require the use of the mule and driver. The cars are of 1½-ton capacity and this small size necessitates a great number of car changes during a working shift—an average day's loading will be in excess of 125 cars. A crew of three trackmen are used to extend the track and switches for the three machine operations.

Timbering

The top usually stands well and seven posts are set in a room after each cut. One timberman does this work for one loading machine operation. No pillars are recovered at this mine.

Summary of Operating Crew for Three Working Shifts

Foremen	2
Machine Operators	3
Machine Helpers	3
Car Pushers	3
Cutting Machine Operators	2
Cutting Machine Helpers	2
Drillers	4
Trackmen	3
Timbermen	3
Drivers	6
Shot Firer	1
Total Men for Three Crews	32

In addition to these, there are two electricians employed for machine repair and maintenance and there is one man on the surface in the shop and supply-house who is also considered as part of the loading machine crews. This makes an average of 12 men for each loading operation to perform all work from the face to the main line sidetrack.

Production Records

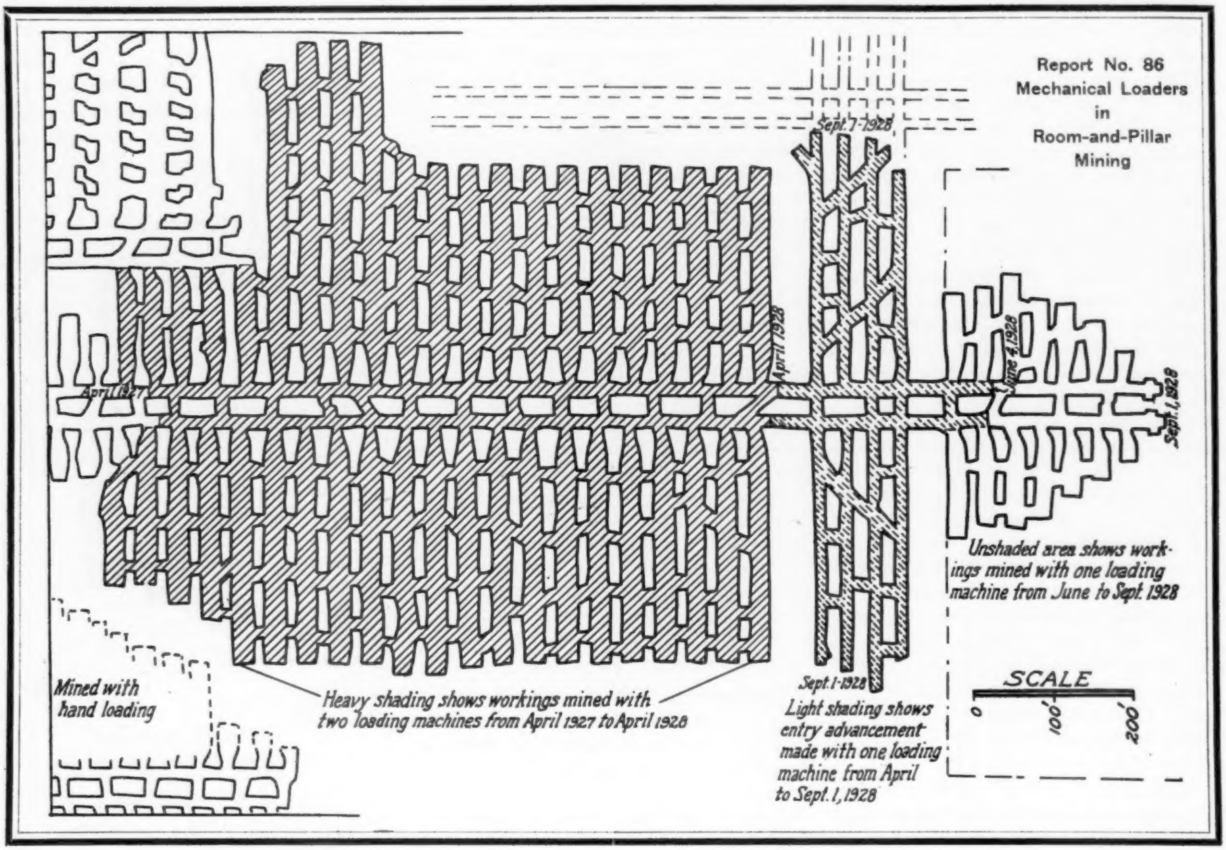
During a recent one-month operation an average of 615 tons was loaded per day. This was with three loading operations—two on the day shift and one on the night—and gives an average of 205 tons per machine shift.

Equipment

For three operations with two loading machines there are two cutting machines, two electric drills and nine mules —three single and three spike teams.

Preparation

No particular effort is made at this mine to produce lump coal. The tipple is equipped with picking tables and shaking screens. The impurities which are removed at the tipple generally occur in lumps of coal and these are passed through a breaker which crushes the coal but leaves the impurities in large sizes so that a very satisfactory separation is made by screening.



MECHANIZATION REPORT NO. 86

By G. B. SOUTHWARD

THE operation described in Report No. 86 is in a mine operated entirely by mechanical loaders in a seam averaging 7 ft. in height. This mine was originally operated by hand loading but several years ago all work was discontinued and the mine closed down. In the early part of 1927 the property was taken over by a new management and work was started to rehabilitate the plant with the intention of operating entirely by mechanical loading and in April, 1927, the first loading machine was installed. Since that time five other units have been added.

Starting in April, 1927, the production at this mine was about one car per day; this was gradually increased as the development was extended and in the succeeding period to September 1, 1928, the total tonnage of 270,072 tons was mined. This includes the period for reopening the mine so that the average daily tonnage for each machine figured from this production does not represent the present performance. The management reports that the mine has now been developed to a production basis, and an average of between 4,000 and 5,000 tons per month per

MECHANICAL LOADERS IN ROOM-AND-PILLAR MINING

machine, or an annual rate of 300,000 tons per year with six loading machines, is now expected.

This operation is an interesting illustration of the advantages of mechanized loading over hand loading. The natural physical conditions underground are not unfavorable for hand loading but the working territory, in the course of a number of years of mining, had become so extended that the maintenance and operation of this property with hand methods was not profitable under present market conditions.

In adapting this mine to mechanized loading a considerable amount of rehabilitation work was necessary for draining, timbering, track and grading, but because of the fact that the mechanized mining would be concentrated into a comparatively small area it was not necessary to reopen all of the original working places in order to produce the tonnage required. Furthermore, the fast rate of entry driving with mechanical loaders has made it possible to develop new panels in a much shorter length of time than would have been possible with hand work. This is well illustrated by the progress shown on the accompanying map.

The map submitted with this report shows a part of the workings at this property which have been mined entirely with mechanical loading from April, 1927, to September, 1928. The completed panel, indicated by the heavy shading, shows the area mined by two loading machines from April, 1927, to April, 1928. In this panel a pair of entries were advanced a distance of 800 ft. and 42 rooms—21 to the right and left—were driven up and completed. These were 24 ft. wide and an average of 300 ft. long. Beyond this panel the light shading shows the advancement made in four main entries with one loading machine operating from April through August, 1928—a five-months period. Each of these headings were driven about 700 ft. and with the breakthroughs this makes a total advancement of approximately 3,200 ft. The unshaded workings to the right of the main entries show the de-

velopment made in a new panel with one loading machine from June to September, 1928—a three months period. In this panel the entries have been driven 300 ft. and a total of 14 rooms—7 to the right and left, are now started and the panel is practically developed to full working capacity. In all of the above described operations the loading has been done on single shift only.

From records at other mines in this field it is reasonably sure that the rate of mining with mechanical loading is twice as fast as with hand work and that the territory required for a given tonnage will be concentrated into one-half the area that would be necessary with hand loading.

OPERATING REPORT

Physical Conditions

The seam has an average height of 7 ft. of hard structure coal. There are no regular partings but intermittent and irregular bands of impurities occur. The top is a slate which stands well in the entries and rooms without excessive timbering. The bottom is fire clay. The seam is generally flat but has local rolls and hills which at times reach a grade of over 10 percent. The cover is slightly over 200 ft. Open lights are used; entries are rock dusted, and the coal is sprinkled at the face.

Mining System

The mine is worked on the advancing room and pillar system with mechanical loading in the entries and rooms. No pillars are drawn as the light cover permits an extraction of about 70 to 75 percent of the coal in the first mining. The entries are driven 12 ft. wide with a 20-ft. chain pillar between; the rooms turned to the right and left off the entries and are 24 ft. wide with a 12-ft. pillar between. In the older panels these were driven 300 ft. long; in the new panels projected for the mechanized loading the rooms are driven 500 ft. long.

In the development work one machine is generally used to advance a set of entries but in a regular panel two machines are used to drive the entries and work the rooms advancing to the right and left off the entries. A machine is usually confined to one side of the panel—six rooms represent the average clean-up during a shift and about twice this number is kept under development so that the other operations of cutting, drilling, etc., may be carried on simultaneously during a shift without interfering with the loading operation.

Cutting and Blasting

The coal is machine undercut to a depth of 6 ft. and is shot with permissible explosives and electric firing. The holes are made with an electric hand drill using 8 shots in a room and 6 in an entry. The coal is fairly well broken down by the shooting although at times a slight amount of digging is required by the machine to loosen a standing shot.

Usually a cutting machine with a crew of two men and a drilling crew of two men is employed with each loading machine unit. Ordinarily this is done on the day shift; however, there are times when the cutting and drilling is slowed down by hard streaks of impurities, and this necessitates extra time for these operations which is usually performed on the night shift. An average of 7 cutting and drilling shifts is usually found necessary for six loading shifts.

Mechanical Loading

The loading machine works and travels from place to place on caterpillar trucks and discharges directly into mine cars. A crew of three men operate each machine—one at the control, one at the head end and one trimming the cars. This work is done on the day shift only. In entry development an average of eight places—each producing from 15 to 20 tons—is loaded during the working shift and in room work an average of six places—each producing about 35 tons—is loaded.

Haulage

A gathering locomotive with one motorman serves each machine shifting single cars as loaded into a near-by room. The mine cars are 3½ tons capacity which is about twice the size formerly used for hand work. This car is illustrated in Figure 2 and it will be noted that the sides are tapered down near one end, which allows the boom of the loading machine to reach up into the front end of the car and reduces the head room required. A single track of 30-lb. steel on 42-in. gauge is laid in the rooms; 40-lb. rail is used on the entries. Four trackmen are employed to extend the track and lay the switches for six loading machine operations.

Timbering

The timbering does not present any particularly difficult problem as the top in the rooms is generally good and stands well for the short length of time required to drive a room to its limit. Two posts are generally set after each cut and a timbering crew of two men is employed for six loading machine operations.

Summary of Regular Crew Employed for Six Loading Machine Operations

Loading Machine Operators	6
Loading Machine Helpers	6
Car Trimmers	6
Gathering Motor Crew	6
Cutting Machine Operators	7
Cutting Machine Helpers	7
Drillers and Helpers	14
Trackmen	4
Timbermen	2

This makes a total of 58 men directly employed for six loading machine operations or an average of 9½ men per machine. With the exception of the extra drilling and cutting, this work is all done on a day shift of eight hours.

Equipment

Each loading machine operation has one cutting machine, one electric drill and one gathering locomotive.

Preparation

There are no figures available to show the sizes of coal as compared with hand mining but the management reports that the screenings with mechanized loading may probably be increased 5 percent over hand mining and that the picking labor required on the table is probably double that required for the same production with hand loading.

Big Electrolytic Zinc Plant to be Built In Illinois

Plans for the erection of a $1,000,000 electrolytic zinc plant at East St. Louis, Ill., by the Evans-Wallower Lead Company, have been completed, according to announcement by Edgar Z. Wallower, president. Work on some units of the project have been started.

The plant has been designed primarily to use low-grade western zinc concentrates, which are desirable on account of the by-product values, according to Mr. Wallower. However, in periods of overproduction in the Tri-State district, zinc concentrates from Joplin will be used to advantage.

"The effect of the operation of a plant of this kind," according to Mr. Wallower, "will be to stabilize the market for concentrates and metal, rather than to disturb the balance between output and consumption."

Equipment of the plant will consist of roasting furnaces, Cottrell electrostatic precipitators for roasting ores and saving dust losses, and buildings containing leaching and purification tanks, filters and motor generators.

The investigations of the company have extended over a year, and included a trial run of concentrates from one of its mills in the Bunker Hill and Sullivan plant at Kellogg.

The tests were said to have been successful in every way, and high-grade metal was produced at a most satisfactory percentage of extraction. As a result of the tests, engineers were commissioned to draft detailed plans and estimates for the new plant.

It is understood that the capacity of the new plant will be about 50 tons of metal a day. The plant has been designed so that its capacity may be doubled by the erection of duplicate units alongside the original buildings.

The Evans-Wallower Lead Company recently was formed by the consolidation of the Tri-State mines of the Golden Rod Mining and Smelting Company with the Evans Lead Company, of Charleston, W. Va. The Evans-Wallower is the fourth largest producer of concentrates in the Tri-State district, having produced 38,058 tons of zinc and 8,240 tons of lead concentrates in 1927.

Large Copper Producers Form Sales Company

The Phelps Dodge Corporation, Nichols Copper Company, Calumet and Arizona Mining Company and Old Dominion Company have announced that they have formed a new agency through which to sell their copper to be known as Phelps Dodge Sales Company, Inc., with offices at 99 John St., New York.

Commencing October 1, 1928, the new company will market all copper heretofore sold by Phelps Dodge Corporation and Nichols Copper Company. This will include the product of Phelps Dodge Corporation, Calumet and Arizona Mining Company, Old Dominion Company; also Nichols Copper Company and their clients including United Verde Extension Mining Company and The Granby Consolidated Mining, Smelting and Power Company, Ltd.

The officers and directors of the new company will be as follows: Walter Douglas, chairman of the board; C. Walter Nichols, president; Gordon R. Campbell, vice president; A. T. Thomson, secretary and treasurer; Walter C. Bennett, chairman advisory committee; Charles A. Austin, manager of sales; Martin H. Crego, assistant manager of sales.

Walter Douglas, C. Walter Nichols, Gordon R. Campbell, Cleveland E. Dodge, Walter C. Bennett, directors.

The new agency, it is estimated, will market about 40,000,000 pounds of copper monthly, including the entire production of the companies named.

Salt Lake Experiment Station Sought

The Senate Committee on Mines and Mining has been asked by the Chamber of Commerce and Commercial Club of Salt Lake City to endeavor to bring about the enactment of legislation to provide increased appropriations for maintenance of existing mining experiment stations throughout the United States and to establish a central experiment station at Salt Lake City.

This request is embodied in a letter from Edward M. Ashton, president of the Salt Lake City organization, to Senator Oddie (Rep., Nev.), chairman of the Senate Committee. An annual appropriation of $500,000 for the maintenance of existing stations and $1,000,000 for the proposed central station is proposed.

The proposal grew out of discussion of bills (S. 708 and S. 1330) introduced at the last session by Senators King (Dem.) and Smoot (Rep.), of Utah, to provide for the establishment of the central station at Salt Lake City, and another bill (S. 2079), introduced by Senator Oddie,

MINE PRODUCTION OF GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA IN 1927

(In terms of recovered or recoverable metal)

(Advance figures by C. N. Gerry, of the United States Bureau of Mines)

County	Mines producing	Ore treated	Gold *	Silver *	Copper	Lead	Zinc	Total value
		Short tons	Fine ounces	Fine ounces	Pounds	Pounds	Pounds	
Cochise	41	2,476,414	63,722.36	2,276,526	140,021,520	12,097,308	899,024	$21,770,534
Coconino	1	22	.48	43	5,151	....	....	709
Gila	29	9,798,268	8,277.59	365,633	173,004,343	475,261	....	23,071,937
Graham	2	12,228	130.42	7,248	17,208	1,377,830	41,878	98,543
Greenlee	6	1,495,473	5,207.62	130,590	59,760,067	1.531	....	8,010,362
Maricopa	12	15,939	3,980.34	37,448	180,780	1,796,974	....	240,405
Mohave	49	120,262	23,959.12	88,683	37,943	758,945	1,186,826	674,304
Pima	31	3,411,451	19,145.62	237,258	75,493,619	1,219,456	....	10,496,790
Pinal	26	3,076,609	8,837.05	1,064,331	91,258,140	1,084,851	....	12,809,316
Santa Cruz	26	6,248	137.72	42,497	541,460	771,068	....	146,451
Yavapai	69	1,575,476	66,841.72	2,584,676	141,641,714	110.327	141.232	21,418,307
Yuma	16	3,484	254.55	12,747	228,602	172,410	....	53,299
Total, 1927	308	21,991,874	200,494.59	6,847,680	682,190,547	19,865,961	2.268,960	$98,790,957 †
Total, 1926	383	22,382,685	234,010.97	7,381,027	723,296,051	23,258,274	12,946.423	113,536,288 ‡

* Includes placer production.

†Average value of metals: Gold, $20.671835 per ounce; silver, $0.567 per ounce; copper, $0.131 per pound; lead, $0.063 per pound; zinc, $0.064 per pound.

‡Average value of metals: Gold, $20.671835 per ounce; silver, $0.624 per ounce; copper, $0.14 per pound; lead, $0.08 per pound; zinc, $0.075 per pound.

which would provide $448,000 for the existing stations for the fiscal year 1929.

"The direct benefits of this to the mineral industry are obvious," said Mr. Ashton in his letter to Senator Oddie, "as the work to be conducted will include all the minerals, nonmetallic as well as metallic. Agriculture will also benefit directly through the development of methods to utilize the vast resources of fertilizing material in western mineral deposits. Improvement of these two great industries of the West will benefit all business and industry."

Fire Destroys Surface Plant at Kennedy Mine—Miners Reach Safety Through Argonaut Shaft

A disastrous fire completely destroyed the surface plant at the Kennedy mine, Jackson, Calif., on September 7. The fire was first discovered in a timber pile near the shaft, and word was immediately sent down to get the men out of the mine. But the fire, fanned by a high wind, reached the headframe before any of the men could be brought out, and this shut off the main operating shaft as a means of egress.

The connection with the Argonaut mine made in the attempt to rescue the Argonaut miners at the time of the Argonaut fire disaster of five years ago, when 47 men lost their lives, now served as a way to safety for the Kennedy miners. Of the 125 men in the Kennedy mine, all but four made their way to the surface through this connection and the Argonaut shaft. The remaining four men, missing for hours, worked their way to the Kennedy north shaft and safely reached the surface.

The fire completely destroyed the surface plant, and also a number of automobiles parked by employes. Burning embers started grass and brush fires, which spread for nearly 2 miles north from the workings before it was brought under control. The direction of the wind was all that saved the town of Jackson.

The Kennedy Company had just completed concrete foundations, and steel was in transit for a new steel headframe to replace the old wooden headframe, which had been in service for many years.

Tri-State Mill Destroyed by Fire

The 300-ton mill at the Patty C mine of the Pearl Mining Company, 6 miles southeast of Picher, Okla., was destroyed by fire early in the morning of September 18, with a loss of between $75,000 and $100,000. It is understood that only a part of the loss is covered by insurance.

The fire was said to have originated from a hot box. The mill had been shut down at 3 o'clock, and the fire was discovered by workmen before leaving the mine. The flames spread rapidly and were soon beyond control.

Idaho Mine Inspector Wins Suit

Stewart Campbell, Idaho State mine inspector, has won the final round in his legal battle with Idaho Copper Corporation, which sued him for $500,000 for libel. The jury verdict returned before Judge Dietrich at Boise, was affirmed recently by the United States Appellate Court at San Francisco.

MINE PRODUCTION OF GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA IN 1927

(In terms of recovered or recoverable metal)

(Advance figures by C. N. Gerry, of the United States Bureau of Mines)

County	No. of producers	Ore treated	Gold *	Silver *	Copper	Lead	Zinc	Total value
		Short tons	Fine ounces	Fine ounces	Pounds	Pounds	Pounds	
Churchill	7	368	60.37	7,078	443	142,859	....	$14,319
Clark	24	11,469	1,286.39	15,843	9,879	1,690,443	3,546,078	370,316
Douglas	4	54	31.06	1,222	....	13,075	....	2,159
Elko	39	56,279	24,271.58	302,480	327,329	2,372,428	40,197	868,160
Esmeralda	39	220,759	22,643.56	1,117,058	2,252	152,237	3,142	1,111,543
Eureka	13	50,888	2,866.99	619,883	52,758	2,440,127	....	571,379
Humboldt	12	520	187.11	10,806	595	5,854	....	10,442
Lander	32	32,846	1,245.61	801,938	1,367,637	402,496	20,510	686,278
Lincoln	10	42,001	762.82	380,112	1,434,702	3,938,036	2,438,395	823,392
Lyon	22	427,000	1,668.60	54,671	9,518,447	3,486	....	1,312,628
Mineral	42	8,500	2,160.57	117,490	48,962	654,930	285,406	177,221
Nye	69	79,374	30,722.58	1,527,312	37,880	2,401,916	....	1,657,361
Ormsby	1	8	.92	524	240	....	....	347
Pershing	22	25,419	2,430.31	168,327	552	96,972	....	151,861
Storey	20	81,827	11,401.50	62,051	1,100	....	....	271,017
Washoe	13	348	402.82	3,796	420	11,269	1,191	11,320
White Pine	40	4,493,492	48,203.37	206,588	107,456,080	1,458,690	9,604	15,282,846
Total, 1927	409	5,531,152	150,346.16	5,397,179	120,259,276	15,784,818	6,344,523	$23,322,589 †
Total, 1926	405	5,884,568	175,381.68	6,518,983	101,827,937	22,367,965	10,817,833	24,549,991 ‡

* Includes placer production.

†Average value of metals: Gold, $20.671835 per ounce; silver, $0.567 per ounce; copper, $0.131 per pound; lead, $0.063 per pound; zinc, $0.064 per pound.

‡Average value of metals: Gold, $20.671835 per ounce; silver, $0.624 per ounce; copper, $0.14 per pound; lead, $0.08 per pound; zinc, $0.075 per pound.

Utah Copper Raises Dividend Rate

The annual dividend rate on the stock of the Utah Copper Company has been raised from $6 to $8 a share, with a quarterly payment of $2 on September 29 to stockholders of record September 14. On this new basis the Utah Copper Company will disburse $3,284,980 per quarter, or $12,995,920 a year.

Field Work Completed in Tungsten Tariff Investigation

Agents of the Tariff Commission have concluded their investigation of domestic tungsten ore production in the commission's inquiry under a Senate resolution as to the differences in the cost of production in this country and China, the principal competing country. The last point of inspection by the agents was at Hereford, Ariz. The commission will investigate the selling prices of Chinese ore in this country for comparative purposes, and it is expected that the report on the investigation will be ready before the end of the year.

New Exploratory Work at Ajo

The Continental Diamond Drilling Company of Los Angeles has started diamond drilling on a property lying about 2 miles south of Ajo, Ariz. The property was recently optioned by Hoval A. Smith, of Bisbee, and C. S. Van Dyke, of Miami. About 2,800 acres are to be tested in the exploratory work in the hope of the development of ore bodies similar to those at the New Cornelia property.

Big Jim Mines Acquire Hardshell Property

The Big Jim Mines, Inc., has purchased the Hardshell mine, located at Hardshaw, about 10 miles from Patagonia, Ariz., from the Richardson estate, and is putting the property in shape for operation. The ore from the Hardshell mine will be treated in the Big Jim mill along with the ore from the Big Jim mine. The Hardshell mine is an old producer and has yielded a fair tonnage of excellent silver lead ores.

United American at Oatman, Ariz., Will Deepen Shaft

A new electric hoisting plant and a new compressor have been installed at the United American property at Oatman, Ariz., and a contract has been let for the deepening of the shaft from the 800 level to the 1,100 level. When the shaft has been deepened lateral work will begin for the testing of the South vein, and also the Aztec vein. This will be the deepest exploratory work in the district.

Cuban American Manganese Corp.

The Cuban American Manganese Corporation was recently organized to succeed the Cuban Mining Company and will transform low grade Cuban manganese ores into commercially shipable concentrates. The process has been approved by Bethlehem Steel Company and Massachusetts Institute of Technology. Immediate renewal of activity in the manganese district is proposed by the new company which owns about 80 percent of known manganese deposits of Cuba. The plant, which will cost about $1,000,000, will be erected immediately and will have a capacity of 1,000 tons daily.

CALIFORNIA NOTES

Work of rehabilitating the Kennedy mine, at Jackson, has already commenced and new equipment has been ordered to replace that destroyed. The Kennedy suffered a disastrous fire September 7, which destroyed all the top workings except the mill and office.

The Central Eureka mine, of Sutter Creek, Amador County, milled 56,774 tons of ore in 1927, from which $447,579 was recovered, or an average value on the ore of $7.88.

California produced 14,260,000 tons of sand and gravel, valued at $8,045,257, in 1927, according to U. S. Bureau of Mines. California ranks fourth among the states in the production of such material.

Six feet of ore that is said to run $21 a ton in gold is being broken in the winze that has been sunk from the 1,080 level of the Royal mine, Calaveras County, according to Herbert White, vice president of the Royal Development Co.

"There is reason to believe that the latent gas resources of the Sacramento Valley are of vast extent and capable of being made of great value," says an editorial in the California Oil World. "Experience has shown that it will be easy to pipe gas from the Sacramento Valley to Portland, Seattle, and even farther north.

The Frank Cook claims in the Meadow Lake District, Nevada County, are being sampled by Los Angeles people, who claim that they will commence development on an extensive scale if values justify.

Plans are being made for the production of chrome ore on the Sousa ranch, near Yreka, Siskiyou County. The ore runs 45 percent chromite, and a market for the concentrate has been found in San Francisco.

Research at Michigan College of Mining and Technology

A single piece of research, accomplished at the Michigan College of Mining and Technology in cooperation with the U. S. Bureau of Mines, will return, each year, to the public a sum approximately equal to the entire amount appropriated for buildings, grounds, and operation of the college from the time it was established in 1886 to date.

This was the startling statement of Dr. W. O. Hotchkiss, president of "Michigan Tech," before the annual meeting of the Lake Superior Mining Institute on the Menominee iron range relative to the research program at the college.

Commenting on the fact that copper milling research, carried on at the college in cooperation with the Bureau of Mines, had demonstrated that the copper lost in the amygdaloid tailings in the Michigan district could be reduced from about 4¼ pounds per ton to about 1½ pounds, Dr. Hotchkiss said:

"It is rare that a more concrete case can be cited to illustrate the value to the public of well-planned and well-executed scientific research. A measure of its importance to the public can be appreciated by the average citizen, if he will but consider that 90 to 95 percent of the gross proceeds of any industry are distributed to the community as payment for labor, supplies, and raw materials, and will also remember that this single piece of research accomplished by the expenditure of a few thousand dollars of public funds will return, each year, to the public a sum approximately equal to the entire sum appropriated for buildings, grounds, and operation of this college from the time it was established in 1886 to the present time. The returns in one year to the public will pay back approximately all the expenditures made in 42 years at this college and give as an additional profit the 42 years of splendid educational results that in themselves have been well worth all they cost. Even if this college did nothing of value for the coming 42 years, the results of this single piece of research will continue to repay the public 100 percent profit each year on their total investment."

The saving of approximately 3 pounds of copper per ton of amygdaloid tailings is equivalent to increasing the selling price of amygdaloid copper roughly 2 cents per pound. "What collateral effects may be produced can not be so readily computed, but there will be much of value in the stimulation of prospecting, and in the distinct possibility that hitherto worthless piles containing tens of millions of tons of amygdaloid tailings may be worked with profit," said Dr. Hotchkiss.

The Michigan legislature in 1927 appropriated to the college the sum of $50,000 per year for two years for research in iron and copper. The governor found it necessary, despite his strong approval and appreciation of the work, to cut the first year's appropriation to $25,000, and this sum became available July 1, 1927. On June 27, 1928, the college was able to announce to the public the success of the copper milling research.

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The Battle is On

Oliver Company Closes Chisholm Mine

The Chisholm open pit mine, at Chisholm, Minn., on the Mesabi Range, completed operations in August, and the equipment has been removed from the pit. The mine, operated by the Oliver Iron Mining Company, and up to a few years ago an underground property, was opened in 1901, and its total shipments of iron ore are close to 9,000,000 tons.

New Company to Exploit Arizona Marble Deposit

The National Marble Corporation has organized in Arizona to exploit a marble deposit in the Dragoon Mountains of Arizona. The marble will be quarried and shipped in the rough to Los Angeles, where it will be finished for the market. The project has been financed in Los Angeles and will be managed by B. D. Blakeslee.

The athletic field at Butte, Mont., where more than 4,000 people attended the International First-Aid and Mine Rescue Contest, August 20, 21, and 22. The team of the Northwest Improvement Company, Roslyn, Wash., won the mine-rescue contest and also highest honors for combination first-aid and mine-rescue teams.

At the right is the team representing the Great Falls plant of the Anaconda Copper Mining Company, which carried off highest honors in the first-aid competition. Walter J. Needham (fourth from the left, standing), formerly with the Bureau of Mines, is the instructor of the team. The others are: Raymond Lipton; Michael Tetrault; Fred Erickson (captain); Nels Nelson; A. McDonald, president, First-Aid Society, Great Falls plant; Matt Parock; A. E. Wiggin, superintendent, Great Falls plant; Edward Schrader, and Gordon Gills.

Personal Items

George A. Packard, consulting engineer of Boston, was in the West in September.

R. W. Prouty, consulting geologist and engineer of Los Angeles, has recently returned from several months' work in the Tri-State district.

Robert B. Whiteside, of Duluth, was in California in September.

John A. Swart, mechanical engineer, has sailed from London for South Africa on his way to the Roan Antelope mines.

George Kingdon, general manager of the United Verde Extension, and Mrs. Kingdon have left for an extended trip to the Orient.

George W. Starr, managing director of the Empire Mines and Investment Company, Grass Valley, Calif., has returned from a trip to South Africa.

P. G. Beckett, vice president and general manager of the Phelps Dodge Corporation, has spent a month in eastern Canada.

L. O. Howard, former dean of mines at Washington State College, has been appointed superintendent of the Chloride Queen Mining & Smelting Company, at Nighthawk, Wash., and will take charge of operations. Mr. Howard will make a thorough inspection of the property and make such plans as he thinks best for its development. The Chloride Queen property is made up of several old claims, including the Ruby and the Nighthawk Tunnel.

Dr. C. A. Mowery, of Spokane, Wash., has been elected to the board of directors of the Delaware Mines Corporation, replacing L. E. Whicher, of New York, who had been the representative of the stockholders in the old Rex Consolidated Mining Company.

C. H. Baxter, head of the mining department of the Michigan College of Mining and Technology, Houghton, Mich., has joined the staff of the St. Mary's Canal Mineral Land Company in the capacity of consulting engineer and geologist, supervising the company's mining and exploring interests. His connection with the Canal Company is in accord with the policy of Michigan Tech to have its teaching staff in close touch with practical operations in their various specialties.

William B. Thompson, mining engineer and banker, New York, was elected an honorary member of the American Institute of Mining and Metallurgical Engineers at its fall meeting in Boston.

W. Gaston Caperton, of Slab Fork, W. Va., has been elected president of the New River Coal Company, Slab Fork Coal Company, Scotia Coal & Coke Company and the South Side Company, vice G. H. Caperton, deceased.

William G. Caperton, of Charleston, who has for some time past been vice president of the New River Coal Company and in charge of sales, becomes vice president of each of the other companies.

At a meeting of the executive committee of the Hudson Coal Company, R. W. Clark was elected vice president and general sales agent of the company, with headquarters at Scranton, Pa., vice D. F. Williams, resigned.

W. A. Maxwell, Jr., has been elected vice president of the Colorado Fuel & Iron Co., Denver, and as vice president and production manager will have charge of all manufacturing, mining and related activities of the company. Mr. Maxwell also was elected vice president of the subsidiary companies, the Rocky Mountain Coal & Iron Co., Colorado Supply Co., and the Colorado Realty Holding Co.

Frank R. Wadleigh has recently been appointed consulting fuel engineer for the Consolidated Gas Company at New York City.

Rob B. Eastin, of Henderson, Ky., has been appointed mine inspector for the first district of Kentucky, including Christian, Crittenden, Hopkins, Union, Henderson and Webster Counties. William Burgess, of Paintsville, for the seventh district, including Floyd, Johnson, Magoffin, Lawrence and Martin Counties. John F. Porter has been named for the eighth district, consisting of Pike County. John H. Howard, of Harlan, has been named inspector for the fifth district.

Robert J. Montgomery, fourth vice president of the Philadelphia & Reading Coal & Iron Company, and his wife have returned from a vacation in Europe.

William H. Cloverdale has been elected president of the Gulf States Steel Company, and John W. Plattern as chairman of the board, the latter succeeding the late James Bowron.

O. P. Hood, chief of the Technologic Branch; A. C. Fieldner, chief of the Metallurgical Division; F. G. Tryon, of the Coal Division, and H. H. Hill, chief of the Petroleum Division, all of the Bureau of Mines, Washington, D. C., have sailed for England to participate in the World Fuel Conference in London the first part of October.

J. E. Sugden, Jr., of the Steel City Gas Coal Company, has been named permanent chairman of the newly organized Pittsburgh Coal Operators' and Distributers' Credit Group, the purpose of which is the exchange of credit information among coal men and affiliation with the National Association of Credit Men. B. H. Canon, of the Fort Pitt Coal & Coke Company, has been named vice chairman.

Illinois Miners Ratify Wage Agreement

By a bare majority of 1,341, members of the Illinois Miners' Union ratified the new wage scale agreement effected by representatives of the union and operators of the state. The vote of 26,838 for ratification and 25,497 against represented the culmination of wage scale negotiations.

Effective September 16, the new wage scale is in force for four years. It represents a decrease in salary of from 16 to 19 percent. The new scale is 91 cents for tonnage and $6.10 for day workers, compared to the old pact of $1.08 for tonnage workers and $7.50 for day men. More than 600 miners of the Capitol mine, near Springfield, refused to go to work September 17, presumably because of the decrease in wages.

When the mine opened all men were on hand but instead of going to work, they held a mass meeting. No statement was made to officials. The men had been working under the Jacksonville wage scale.

Officials of the mine said that if the men refused to return to work others would be obtained.

West Virginia Safety Meet

The first aid team of the Consolidation Coal Company's mine No. 86, Carolina, W. Va., won the state-wide first aid contest at Bluefield, September 22. This was the feature event of West Virginia's third annual safety meet, held under the auspices of the State Department of Mines. Second place went to the Booth mine team of the River Seam Coal Company, Morgantown, and third place was awarded the team of the Fordson Coal Company, Twin Branch.

One hundred and eighty teams were entered in the contest, which marked the annual observance of Safety Day in West Virginia, a tournament developed by R. M. Lambie, chief of the State Department of Mines, to bring forcibly to the attention of operators and miners alike the advantages of exercising caution in the operation of the mines.

Fourth place in the first-aid contest was won by the team of the Cranberry Fuel Company's No. 1 mine, Cranberry. Fifth place went to the team of the No. 2 mine of the United States Coal and Coke Company, at Gary, while the Holden team of the Island Creek Coal Company took sixth place.

As winner of the tournament, the Consolidation team was given a banner from the State Department of Mines. Members of teams winning the first four places were given loving cups and bronze medals were awarded members of the last two winning teams.

Governor Gore, an interested spectator at the tournament, stressed the importance of the safety movement in an address before the gathering. J. G. Bradley, president of the West Virginia Coal Association, who presented the prizes, also made an address. Chief Lambie made a short talk to the competing teams after the tournament.

Composing the 180 competing teams were 1,080 active team members in addition to a number of substitutes. Each team consisted of a captain, four men and a patient. The problems they were called upon to solve represented the treatment of all manner of injuries which might be sustained in mine accidents.

Eight boy scout teams participated with the miners in the contests and three winners were awarded cash prizes.

Harry L. Gandy, executive secretary of the National Coal Association, in an address, detailed the progress of mine safety work in West Virginia and declared that the progress was due to the interest of the operators, the loyalty of the miners and the zeal of Chief Lambie.

Ohio Mine Tipple Destroyed by Fire

The tipple of the Lawler mine No. 7, near Clarion, Ohio, and operated by John L. Lawler & Son, was totally destroyed by fire on September 10, with a loss of about $15,000. The fire was caused through a short circuit in the air compressor used to operate the tipple. The mine was a union operation.

Wallace Press-Times

Why Mothers Get Gray!

Anthracite Body Asks Tax Repeal

The anthracite coal region, which has sponsored bills repealing the anthracite coal tax ever since the state began collecting the impost, has begun its drive, four months prior to the convening of the legislature, to wipe the act off the statutes.

Forty-five representatives of the Anthracite Cooperative Association presented a petition to the governor and the 1929 session of the legislature asking for the repeal and setting forth that the state revenues are now such that no branch of the government would suffer if the treasury is deprived of the $5,500,000 collected through the levy of 1½ percent on all anthracite at the mouth of the mines.

The present coal tax act was passed in 1921, and at succeeding legislatures efforts to have it repealed have been made on the ground that it was a detriment to the anthracite industry and to the prosperity of the anthracite district in general.

To Inspect Electrical Equipment in Bituminous Mines in Effort to Reduce Hazard

The Pennsylvania State Department of Mines, through the appointment of four electrical experts, who will inspect mines in the bituminous district, will endeavor this fall to reduce the hazards of coal mining from defective electrical equipment.

Secretary Walter H. Glasgow, of the Department of Mines, has been authorized by Governor Fisher to make the appointments. The selection will be made soon and the inspectors will assist the present force in installing electrical equipment in mines and in gaseous parts of mines. Especial attention is to be given electrically operated coal-cutting machines and mine locomotives. The appointments will be made so that the inspectors can begin the duties by October 1.

Special study in the past has been given the anthracite mines, and Secretary Glasgow is of the opinion that more attention should be paid now to the soft-coal mines. One of the inspectors will be located in each of the following cities: Pittsburgh, Uniontown, Johnstown, and Greensburg. A recent survey of the situation by the secretary

caused him to believe that faulty electrical equipment in the bituminous mines has been responsible for the worst mine accidents of this year. The five worst have occurred in the bituminous field.

Lehigh Coal's Advertising Campaign

A booklet, entitled "Helping the Coal Merchant to Sell Old Company's Lehigh," has been published by the Lehigh Coal & Navigation Company for those who sell the company's product. It shows and tells about some of the things that will be done this fall by the producers of Old Company's Lehigh anthracite to further the sales and is the beginning of an extended campaign. In its pages are shown the actual advertisements in full size, just as they will appear in the newspapers during the period from September 5 to January 23, and gives the names of the papers printing them, covering the eastern States, Ohio, and eastern Canada. Another campaign will follow in the spring of 1929.

The company's dealers have also been furnished with another booklet containing 37 advertisements for use in local newspapers. They are available in either "electro" or "mat" form, as may be preferred. There is a series on each of the following themes: "Reliability," "Service," and "Substitute Fuels."

Another interesting feature of this campaign is a radio program broadcast through 11 prominent eastern stations every Sunday evening.

$250,000 Improvements to Alabama Coal Mine

The Bankhead mine, operated by the Cane Creek Coal Mining Company, a subsidiary of the Consolidated Coal Company, was recently completed at a cost of $250,000. New cars and 15-ton electric locomotives have been installed and all necessary work of straightening out and improving the inside workings has been done.

The tipple is of steel construction and is capable of handling 4,000 tons of coal per 8-hour day. The washer, of lumber and concrete, has four Elmore jigs, with a capacity of 1,200 tons per day. More jigs are to be added as the output and conditions warrant.

The plant is capable of producing 15 separate grades of prepared coal and is said to be the most complete and modern coal handling and washing plant in the South, the entire outside plant being controlled from a switchboard by one man.

The present output of the Bankhead mine is about 1,750 tons per day.

Pittsburgh Coal Company's New Record

The Pittsburgh Coal Company established a new high record for open-shop production in the Pittsburgh district in August, when 930,456 tons were produced, comparing with 814,908 tons in July.

Government Files Another Brief in Lake Cargo Coal Case

The Government filed in the Supreme Court an additional brief in the Lake Cargo Coal case, in which the Interstate Commerce Commission would prohibit the Chesapeake and Ohio, the Norfolk and Western, the Louisville and Nashville, and other railroads from making a reduction of 20 cents a ton in the coal rates from West Virginia, Virginia, Tennessee and Kentucky to Lake ports.

The brief was submitted to show the right claimed by the Government to appeal the case to the highest court from the decision of the statutory court at Charleston, W. Va., which held that the order of the commission directing the railroads to cancel the reduced rates was beyond its power and therefore invalid.

Rocky Mountain Coal Mining Institute

The summer meeting of the Rocky Mountain Coal Mining Institute was held at Rock Springs, Wyo., August 27, 28, 29. The meeting was well attended, and the program included papers on safety, the work of the State Mining Department of Wyoming, mechanical loading, fuel conservation, commercial preparation of coal, time study, and the report of the Safety Committee of the Institute. The program also included a banquet to members and their guests, followed by dancing.

During the afternoon of the second day of the meeting, inspection trips were taken of the No. 8 mine of the Union Pacific Coal Co., the Dines, Wyo., operations of the Colony Coal Company, and the Superior, Wyo., operations of the Premier Coal Company.

Coal Directory

The 1928 edition, the latest number of MAC'S COAL DIRECTORY AND BUYERS GUIDE, published by the Coal Information Bureau, is just off the press.

The publication attempts to furnish a complete, accurate and concise compilation of necessary information on the Coal and Coke Industries from the standpoint of the Buyer, Seller and Consumer of Coal and Coke.

In addition to a complete list of all selling and operating companies in the United States and Canada, the 1928 edition features two new and useful sections: The "Buying Section," wherein is listed all products used in the production, sale, transportation and consumption of coal and coke, together with the names and addresses of the manufacturers and distributors thereof. A "Purchasing Agents Section" in which is listed the names of purchasing agents of all active coal mines together with full shipping instructions thereof.

Safety Engineers Define Lost-Time

Safety engineers of the Tri-State district, at a meeting held at the Picher, Okla., offices of the Tri-State Zinc and Lead Ore Producers' Association recently, defined a lost-time accident as follows:

(a) When the injured employe loses more than the day upon which he was injured.

(b) When an injured employe is unable to do his regular work or its equivalent.

(c) Where compensation is paid for a specific injury, but no day's work lost.

Such a definition will allow a company to keep a man at work in a place where he will be able to earn the same wage, or approximately the same wage, as he was drawing for the job on which he was working when injured and will save the employe from losing time and will not cost the company compensation. At the same time it will prevent companies from paying an injured employe wages which he is not earning, just in order to compile a safety record.

Hazle Brook, Jeddo-Highland and Buck Mountain First-Aid Contest

The First-Aid Contest of the Hazle Brook Coal Company, Jeddo-Highland Coal Company and the Buck Mountain Coal Company, held at Hazle Park, Hazleton, Pa., August 25, was largely attended, representatives of many of the operating companies being present. Donald Markle, president of the combined companies, opened the contest, expressing his pleasure at the large turnout of teams, and told of his interest in rescue work.

Hazle Brook No. 4 first-aid team won the first prize of $100, and the Hazle Brook Coal Company, silver cup, with a perfect 100 percent score.

Westwood outside, which had landed the cup for two years, and would have kept it permanently if it had gained first place, won the second prize of $75.

Buck Mountain Coal Company, Gowan outside team, won the third prize of $50.

Jeddo No. 7 team won the fourth prize of $25, and the Markle cup offered by the Jeddo-Highland Coal Company, to the team making the best record of their twelve teams.

Thirty-three teams competed. The low est score was 98 percent, which indicates the high quality of the performance of all.

Efforts Being Made to Place Import Duty on Anthracite Screenings

On behalf of the Nova Scotia Steel and Coal Company, Ltd., and the Dominion Coal Company, Ltd., R. M. Wolvin, president, has requested the Canadian Government to place an import duty on anthracite screenings for the reason that this grade of anthracite competes with and displaces bituminous coal mined in Canada. The application to the Canadian Tariff Advisory Board states:

"Anthracite screenings are, as the trade name, 'steam sizes,' indicates, used for steam raising, instead of or in combination with bituminous coal. The disposal of steam sizes anthracite and anthracite dust made in the sizing of domestic anthracite is, and always has been, a problem of the anthracite producers, and is becoming increasingly so.

"The report of the Dominion Fuel Board on 'Coke' (Mines Branch Publication No. 630, 1925, page 10) points out that future supplies of American anthracite will have to come from the Schuylkill field, because of exhaustion of the Wyoming field, and that, owing to the deep-faulted and steeply inclined nature of the seams, which have been much folded and contorted by rock pressures in the Schuylkill area, there will result from future anthracite mining 'a lower yield of domestic coal, or at least a larger production of steam sizes,' which, as the report points out, 'must compete in price with bituminous coal.'

"The railways serving the anthracite region, whose interests are closely interwoven with the anthracite industry, recognize the problem of disposal of the steam sizes and carry them at lower rates than the domestic sizes of anthracite.

"We suggest that the advisory board would without difficulty obtain through the Railway Commission particulars of the tonnage of steam-sizes anthracite shipped into Canada; for example, the Delaware & Hudson Railway could give the quantities carried at the above-mentioned lower freight rates into the Montreal district.

"The annual importation of steam sizes of anthracite runs from 250,000 to 400,000 tons per annum, and displaces a similar quantity of bituminous coal subject to duty.

"A delegation, of most representative nature, which waited upon the government on the 2nd of December, 1924, headed by the Premier of Nova Scotia, submitted a request that an import duty equal to that placed upon bituminous coal be also placed upon anthracite screenings, on the ground that this by-product of anthracite mining in the United States, competing directly with Nova Scotia coal for steam-raising purposes, should be dutiable at the same rate as bituminous coal.

"The special committee of the House of Commons investigating the coal resources of Canada reported on June 22, 1926, and advised, among other recommendations, that the duty of 50 cents per ton now imposed on bituminous coal should be extended to apply to anthracite small sizes.

"It is requested that the board give favorable consideration to recommendation of a duty upon anthracite small sizes, because this grade of anthracite competes with and displaces bituminous coal mined in Canada, which is placed at a disadvantage, firstly, by the low pitmouth price of this by-product of anthracite mining; secondly, by the low freight rates granted on the United States railroads; and, thirdly, by admission without payment of duty.

"Consideration is also asked of the probability of increase in the tonnage of small-sizes anthracite seeking disposal at low prices, for the reasons pointed out by the Dominion Fuel Board, previously mentioned.

"In support of this request the coal companies making submission hereof ask consideration by the board of the representations of the Nova Scotia delegation, and of the special committee of Parliament previously mentioned."

Prof. Thomas J. Barr Dead

Prof. Thomas J. Barr, 48 years of age, head of the Department of Mining Engineering at the University of Kentucky, Lexington, died at his home in Louisville, September 6. Professor Barr was a native of Lebanon, Ky., and graduated from the University of Kentucky. In January, 1909, he was made Kentucky state mine inspector. In 1919 he became superintendent of the Kentucky Block Cannel Coal Company, and in 1921 became professor of mining engineering at the University of Kentucky.

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Immortal longings

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The President has taken up target practice

Joseph A. Jeffrey Dies

Joseph Andrew Jeffrey, chairman of the board of directors and founder of the Jeffrey Manufacturing Co., died at his home in Columbus, Ohio, Monday, August 27, at the age of 92. In addition to his interests in the Jeffrey Manufacturing Co. he was also interested in numerous other industries and enterprises in Columbus, and was recognized as one of the city's leading business men in the days before advancing age compelled him to relinquish many of his activities.

Mr. Jeffrey was born at Clarksville, Ohio, January 17, 1836. He came to Columbus in 1858, where he entered into the banking business. He remained there until 1863, and then removed to Cincinnati. After three years he returned to Columbus and acquired a controlling interest in the Lechner Machine Co. The company has been known successively as the Lechner Mining Machine Co., the Lechner Manufacturing Co., and the Jeffrey Manufacturing Co.

In addition to Mr. Jeffrey's interest in the Jeffrey concern, he also was owner of the Ohio Malleable Iron Co.; a stockholder, vice president and director of the Commercial National Bank; and a stockholder and director in the former Ohio Trust Co.

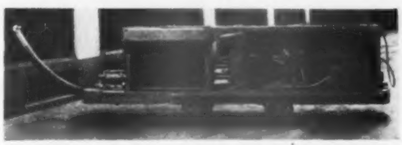
He leaves three sons and two daughters. The sons are Robert H. Jeffrey, president and general manager of the company; Joseph W. Jeffrey, vice president of the firm; and Malcolm D. Jeffrey, assistant sales manager.

Frictionless Bin Gate

Stephens-Adamson Mfg. Co., Aurora, Ill., announce an interesting new gate or valve for regulating the flow of material from overhead bins. With this device R. W. Moore, the inventor, seems to have eliminated the friction encountered in *dragging* the usual gate plate from under the tons of material resting upon it. The Moore Gate might be described as a compact belt conveyor, the frame of which can be moved back and forth under the bin opening. When closed, the wide belt completely closes the opening. In operation, a hand wheel rotates the head pulley, which instead of pulling the belt rolls the frame out from under the gate opening, allowing material to discharge as the belt is rolled from the opening. The gate is closed by turning the hand wheel in the other direction and rolling the belt back under the opening.

A High-Pressure Rock Duster

The Mine Safety Appliances Company, of Pittsburgh, have developed a high-pressure rock dust distributor, illustrated below, with which it is possible to completely rock dust a mine; that is, all open, accessible places, including haulage ways, air coures, rooms up to the last breakthrough and development entry beyond the trolley wire. To accomplish this, the machine is equipped with a special type of 3-in. rubber hose in 50-ft. lengths, with light wire reinforcement. A rotary positive pressure blower, delivering 750 cu. ft. of free air per minute at a speed of 1,150 r. p. m., makes



it possible to carry the dust through 500 ft. of this hose. When dusting haulage entries, a 4-in. hose, 4 ft. in length is used.

This M-S-A machine is described in detail in a booklet, which may be obtained from the Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh, Pa.

Swing Hammer Pulverizers

Showing how widely applicable is the swing-hammer principle of reduction, the Jeffrey Manufacturing Company, of Columbus, Ohio, has recently published, in 32 pages, their Catalog No. 450. This catalog lists fifty-four basic materials, differing widely in consistency, size and weight, all of which may be successfully reduced by Jeffrey Swing Hammer Pulverizers.

Distinctive from the many specialized forms of the Jeffrey Swing Hammer Pulverizer are the Type A and the Type B, which form the two general groups. The Type A is a general-purpose machine suitable for reducing dry-rock products and many friable materials to the degree of fineness required for many purposes. The material is fed into the path of rapidly revolving hammers. The partially reduced material immediately passes over the cage of screen bars. The oversize is carried around the machine for a second operation. Six sizes are listed, and tables are given showing capacities for the materials most commonly used.

In the Type B the illustrations show how the material is fed directly on top of the hammers, so that much of the reduction takes place in suspension. The Type B, of extra heavy construction, is specified for the unusually severe jobs. The tables give eight sizes, and the capacities for limestone, coal, burnt lime and gypsum. The largest Type B shown is the Jeffrey Armorplate, 54 in. by 48 in., for reducing steam shovel limestone to 1 in. and finer in one operation. The machine does the work of both a primary and secondary crusher.

Two interesting special adaptations of Jeffrey Pulverizers described in this catalog are the Limepulver and the Coal Sampler. The Limepulver combines a jaw crusher, swing-hammer pulverizer, bucket elevator and a spout, the whole mounted on wheels. It is the only machine built which performs the double purpose of crushing one-man-size limestone and pulverizing all of it to the proper size for soil treatment.

A copy of this pulverizer catalog No. 450 may be had by writing the Jeffrey Manufacturing Company.

Benjamin F. Faunce Joins Brown-Fayro Company

Benjamin F. Faunce has tendered his resignation as superintendent of the Car Department of the Cambria plant of the Bethlehem Steel Co., in order to devote his time to the operation of the Brown-Fayro Co., manufacturers of mining machinery, tipples, chutes, pumps, etc.

Mr. Faunce organized the Fayro Machine and Engineering Co., of Johnstown, in 1921. On October 1, 1925, the Fayro concern was merged with the Brown Equipment Co. as the Brown-Fayro Co., and recently announced a program of expansion, taking over the manufacture of mine pumps, etc. It was with the idea of carrying out this extension program that Mr. Faunce has resigned, and hereafter will be actively interested in the Brown-Fayro Co. He is the present chairman of the board of directors of the company, which has its plant at Sheridan, Pa.

Rapid Narrow Driving in Low Coal

"Rapid Narrow Work Driving in Low Coal" is the title of Bulletin 2801, just issued by the Goodman Manufacturing Company.

All low-coal operators know the difficulties of mining thin seams and that fast narrow driving for rapid development is the key to steady and high tonnage. Many experiments have been made in the past to increase the speed of advancing narrow work. Some have clung to hand loading, others have applied mechanical loading, with results variously satisfactory. Recent experiments in application of the Goodman Entryloader have developed a new method which advances 12-ft. narrow work three or more machine cuts each shift of eight hours, which method is now being followed successfully in many mines.

Copies of Bulletin 2801 may be obtained from the company, Halstead Street at Forty-eighth, Chicago, Ill.

Application of Roller Bearings to Mine Equipment

The Timken Roller Bearing Company, Canton, Ohio, has issued an interesting and excellently illustrated publication covering the application of roller bearings to mine equipment, including cars, locomotives, journals, motors, conveyors, fans and loaders. It contains the most up-to-date information on this subject. Copies may be obtained from the company.

"The Manganese Steel"

The American Manganese Steel Company has recently issued a pocket-size brochure, entitled "The Manganese Steel." It thoroughly describes Amsco Manganese Steel as to its history, advantages and application, dwelling mostly on facts, and giving to buyers of alloy steel parts and the engineering fraternity a short, interesting summary for quick interpretation, and a complete knowledge of Manganese Steel and its advantages.

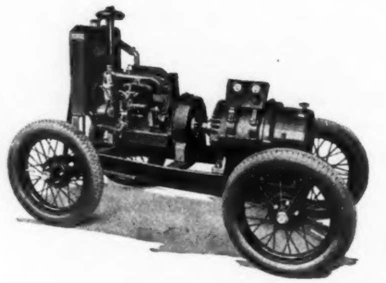
A copy may be obtained by writing to the American Manganese Steel Company, 333 North Michigan Avenue, Chicago.

How Powdered Coal Stands Today

A reprint of a technical article, entitled "How Powdered Coal Stands Today," by Henry Kreisinger, research engineer, Combustion Engineering Corporation, New York, may be obtained from the Combustion Engineering Corporation. In the article such questions as methods of firing, furnace design, rates of combustion, and removal of ash are discussed comprehensively.

Portable Arc Welder

The Fusion Welding Corporation, Chicago, Illinois, has designed a portable arc welding unit, driven by a gasoline motor. Two sizes are made, a 200-ampere unit driven by a 23 hp. motor, and a 300-ampere size with a 40-hp. motor. It is mounted on four wheels, equipped with pneumatic tires or smaller iron wheels.



Prest-O-Lite Flood Light Attachment

The Prest-O-Lite Co., Inc., 30 E. 42d Street, New York City, announces a flood-light attachment of new design for use with the familiar small tanks of dissolved acetylene, the same as are used for truck and tractor lighting.

Prest-O-Lite gas tanks are available from service stations throughout the country. By the connection of the attachment a convenient, portable, powerful flood-lighting unit is obtained which can be used for illumination in dark places and for facilitating night work of all kinds.

The reflector, which is 10 inches in diameter, can be taken off by removing a single knurled nut. A new type of burner is used which will not "carbon up." This burner is placed at a fixed focal point and requires no adjustment.

Improved Single-Phase Motors

The General Electric Company announces an improved single-phase, repulsion induction motor. This motor, in sizes including ¾, 1, 1½ and 2 hp. at 1,800 r. p. m., supplements the present General Electric line of SCR motors. It is of the constant-speed, high-starting torque type for general application.

The motor is enclosed except for ventilating openings in the lower portion of each end shield. With only a slight change in the enclosing features the motor may be made of the totally enclosed type, somewhat reducing the rating.

The National Electrical Manufacturers Association will hold its fall meeting during the week of October 29, 1928, at Briarcliff Lodge, Briarcliff, N. Y.

General Electric Publications

The following additional leaflets to the G-E catalog have been issued by the General Electric Company, each one describing in detail the products mentioned:

Totally inclosed motors for use in explosive atmospheres; coal and ore-bridge equipment for alternating-current operation; A-c inclosed magnetic switches; general purpose synchronous motors; type WD-200A arc welder—belt, motor, or gas-engine drive—stationary or portable; G-E automatic welding head and control.

Traylor Eng. and Mfg. Co.

The Traylor Engineering & Manufacturing Co. has assigned to its Chicago District Sales Office at 1414 Fisher Building, Mr. Foster E. Benner, in the capacity of sales engineer. Mr. Benner has been connected with the main office at Allentown for a number of years as an engineer, and is thoroughly conversant with the company's traditions and policies, as well as familiar with every detail of the company's business. The Chicago district manager is Mr. Benard Haislip, who has officiated in that capacity for a number of years.

The Erie Railroad Co. has bought a 300-hp. oil-electric locomotive from the Ingersoll-Rand Co., the General Electric Co., and the American Locomotive Co. This is the fourth of these units purchased by the Erie Railroad Co.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of THE MINING CONGRESS JOURNAL, published monthly at Washington, D. C., for October 1, 1928.

City of Washington,
District of Columbia, ss:

Before me, a notary public in and for the state and county aforesaid, personally appeared R. S. Mowatt, who, having been duly sworn according to law, deposes and says that she is the assistant business manager of THE MINING CONGRESS JOURNAL, and that the following is, to the best of her knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, printed on the reverse side of this form, to wit:

1. That the names and addresses of the publisher, editor, and business managers are:

Name of publisher, The American Mining Congress; post-office address, Washington, D. C.

Editor, E. R. Coombes.

2. That the owners are: The American Mining Congress—a corporation, not for profit. No stockholders. J. G. Bradley, president, Dundon, W. Va. Robt. E. Tally, first vice president, Clarkdale, Ariz. Geo. B. Harrington, second vice president, Chicago, Ill. J. F. McDonald, third vice president, Leadville, Colo. J. F. Callbreath, secretary, 841 Munsey Bldg., Washington, D. C.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

R. S. MOWATT,
Assistant Business Manager.

Sworn to and subscribed before me this 22nd day of September, 1928.

[SEAL] THOMAS C. WILLIS.

(My commission expires January 4, 1932.)

BUYER'S DIRECTORY

ACETYLENE, Dissolved (Or in Cylinders)
Prest-O-Lite Co., Inc., 30 E. 42d St., New York City.

ACETYLENE GAS
Prest-O-Lite Co., Inc., 30 E. 42d St., New York City.

ACETYLENE GENERATING APPARATUS
Oxweld Acetylene Co., 30 E. 42d St., New York City.

ACID, SULPHURIC
Irvington Smelting & Refining Works, Irvington, N. J.

AERIAL TRAMWAYS
American Steel & Wire Co., Chicago and New York.

AFTERCOOLERS (Air)
Ingersoll-Rand Co., New York City.

AIR COMPRESSORS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.

AIR COMPRESSOR OILS
Standard Oil Co. (Ind.), Chicago, Ill.

AIR FILTERS—Bag type
American Coal Cleaning Corpn., Welch, W. Va.

AIR HEATERS
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

AIR LIFT PUMPING
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.

ANNUNCIATOR WIRES & CABLES
John A. Roebling's Sons Co., Trenton, N. J.

ANNUNCIATOR WIRES & CABLES, INSULATED
American Steel & Wire Co., Chicago, Ill., and New York.

ANTI-RUST OILS & GREASES
Standard Oil Co. (Ind.), Chicago, Ill.

ARMATURE COILS & LEADS
General Electric Co., Schenectady, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

ARMORGRIDS
Hendrick Mfg. Co., Carbondale, Pa.
General Electric Co., Schenectady, N. Y.

ASPIRATORS
American Coal Cleaning Corpn., Welch, W. Va.

AUTOMATIC CAR & CAGER STOPS
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.

AUTOMATIC CAR CAGES
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

AUTOMATIC CAR DUMPERS
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

AUTOMATIC FLAGGING SIGNALS
American Mine Door Co., Canton, Ohio.

AUTOMATIC (Mine Doors, Trucks and Electric Switches)
American Mine Door Co., Canton, Ohio.

AUTOMATIC MINE SWITCHES
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

AUTOMATIC SWITCH THROWERS
American Mine Door Co., Canton, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

AUTOMOBILE CABLES
John A. Roebling's Sons Co., Trenton, N. J.

BAG TYPE AIR FILTERS
American Coal Cleaning Corpn., Welch, W. Va.

BALLAST UNLOADER ROPES
John A. Roebling's Sons Co., Trenton, N. J.

BALL BEARINGS
S K F Industries, 40 E. 34th St., New York City.

BALL & ROLLER BEARINGS
S K F Industries, 40 E. 34th St., New York City.

BARS, STEEL
Carnegie Steel Co., Pittsburgh, Pa.
Timken Roller Bearing Co., Canton, Ohio.

BATTERIES
E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.

BATTERIES, Armature
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BATTERIES, Blasting
Hercules Powder Co., Wilmington, Del.

BATTERIES, DRY (for Bells, Buzzers, Signals, Blasting)
National Carbon Co., Inc., 30 East 42nd St., New York City.

BATTERIES (Storage, Gas Welding, Cutting, Dissolved Acetylene)
Prest-O-Lite Co., 30 East 42d St., New York City.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BEARINGS
S K F Industries, 40 E. 34th St., New York City.

BEARINGS (for all kinds of equipment)
Hyatt Roller Bearing Co., Newark, N. J.

BEARINGS, ANGULAR CONTACT
S K F Industries, New York City.

BEARINGS, ANTI-FRICTION
S K F Industries, New York City.

BEARINGS, ARMATURE
S K F Industries, New York City.

BEARINGS, AUTOMATIC
S K F Industries, New York City.

BEARINGS, BALL
S K F Industries, New York City.

BEARINGS, JOURNAL, CAR & LOCOMOTIVE
S K F Industries, New York City.

BEARINGS, MOTOR, ELECTRIC
S K F Industries, New York City.

BEARINGS RADIAL
Timken Roller Bearing Co., Canton, Ohio.
S K F Industries, New York City.

BEARINGS, ROLLER
S K F Industries, New York City.

BEARINGS, SHAFT, SELF-OILING
S K F Industries, New York City.

BEARINGS, TAPERED ROLLER
Timken Roller Bearing Co., Canton, Ohio.

BEARINGS, THRUST
S K F Industries, New York City.
Timken Roller Bearing Co., Canton, Ohio.

BELL CORD
John A. Roebling's Sons Co., Trenton, N. J.

BELT DRESSING
Standard Oil Co. (Ind.), Chicago, Ill.

BELTING (Conveyor, Elevator, Transmission)
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

BELTING, SILENT CHAIN
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

BINS (Coke and Coal)
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

BITS, Carbon (Diamonds) for Core Drill
R. S. Patrick, Sellwood Building, Duluth, Minn.
Diamond Drill Carbon Co., World Bldg., New York.

BITS, Diamond Drilling
R. S. Patrick, Sellwood Building, Duluth, Minn.

BIT SHARPENERS
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.

BLACK DIAMONDS
Diamond Drill Carbon Co., World Bldg., New York.
R. S. Patrick, Sellwood Building, Duluth, Minn.

BLACK OILS
Standard Oil Co. (Ind.), Chicago, Ill.

BLASTING ACCESSORIES
E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.

BLASTING CAPS
E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.
Hercules Powder Co., Wilmington, Del.

BLASTING MACHINES
E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.
Hercules Powder Co., Wilmington, Del.

BLASTING POWDER
E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.
Hercules Powder Co., 934 King St., Wilmington, Del.

BLASTING SUPPLIES
Hercules Powder Co., 934 King St., Wilmington, Del.

BLASTING UNITS (Dry Battery)
National Carbon Co., Inc., 30 East 42nd St., New York City.

BLOCKS, PILLOW
S K F Industries, New York City.

BLOWERS, CENTRIFUGAL
American Coal Cleaning Corpn., Welch, W. Va.
General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York City.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Robinson Ventilating Co., Zelienople, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BLOWERS (or Compressors)
General Electric Co., Schenectady, N. Y.

BLOWERS (Tubing)
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Robinson Ventilating Co., Zelienople, Pa.

BLOWERS (Turbine)
Robinson Ventilating Co., Zelienople, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BLOWPIPES, Brazing, Carbon Burning, Cutting, Lead Burning Welding, Welding and Cutting
Oxweld Acetylene Co., 30 E. 42d St., New York City.

BLUE CENTER STEEL WIRE ROPE
John A. Roebling's Sons Co., Trenton, N. J.
Phillips Mine & Mill Supply Co., Pittsburgh, Pa.

BOND TERMINALS
American Mine Door Co., Canton, Ohio.

BORTZ
R. S. Patrick, Sellwood Building, Duluth, Minn.
Diamond Drill Carbon Co., World Bldg., New York.

BRACES, GAUGE
Central Frog & Switch Co., Cincinnati, Ohio.

BRACES, RAIL
Central Frog & Switch Co., Cincinnati, Ohio.

BRACES, TRACK
Central Frog & Switch Co., Cincinnati, Ohio.

BRAZILIAN ROCK CRYSTAL
Diamond Drill Carbon Co., World Bldg., New York.

BREAKER MACHINERY
American Rheolaveur Corporation, Wilkes-Barre, Pa.
Vulcan Iron Works, Wilkes-Barre, Pa.

BREAKERS
American Coal Cleaning Corpn., Welch, W. Va.

BREAKERS (Construction and Machinery)
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.

BREAST MACHINES
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.

BRIQUETTING MACHINERY
Vulcan Iron Works, Wilkes-Barre, Pa.

BRUSHES (Carbon, Graphite and Metal Graphite for Electric Motors, Generators and Converters)
National Carbon Co., Inc., Cleveland, Ohio, and San Francisco, Calif.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BUCKETS (Elevator)
Hendrick Mfg. Co., Carbondale, Pa.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

CABLE COMPOUNDS
Standard Oil Co. (Ind.), Chicago, Ill.

CABLE GREASE
Keystone Lubricating Co., Philadelphia, Pa.

CABLES
American Steel & Wire Co., Chicago and New York.
Roebling's Sons Co., John A., Trenton, N. J.
Ohio.

CABLES (Connectors and Guides)
American Mine Door Co., Canton,

CABLES, INSULATED
General Electric Co., Schenectady, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.

CABLES, SUSPENSION BRIDGE
John A. Roebling's Sons Co., Trenton, N. J.

CABLEWAYS
American Steel & Wire Co., Chicago, Ill., and New York.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

CAGE DUMPERS, ROTARY
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

CAGES (Safety Appliances)
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.

CAGE STOPS & LOCKS
Link-Belt Co., 300 W. Pershing Rd. Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Roberts & Schaefer Co., Chicago, Ill.

CAGERS, AUTOMATIC
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Phillips Mine & Mill Supply Co., Pittsburgh, Pa.
Roberts & Schaefer Co., Chicago, Ill.

CAGERS, AUTOMATIC & MANUAL
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Roberts & Schaefer Co., Chicago, Ill.

CAGES
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.

Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

CAGES (Self-dumping)
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

CALCINERS
Vulcan Iron Works, Wilkes-Barre, Pa.

CALCIUM CARBIDE
Union Carbide Sales Co., 30 East 42nd St., New York City.

CARBON AND BORTZ
Diamond Drill Carbon Co., World Bldg., New York.
R. S. Patrick, Sellwood Building, Duluth, Minn.

CARBON FOR DIAMOND DRILLING
Diamond Drill Carbon Co., World Bldg., New York.
R. S. Patrick, Sellwood Building, Duluth, Minn.
Sullivan Machinery Co., 122 So. Mich. Ave., Chicago, Ill.

CARBON BURNING APPARATUS
Oxweld Acetylene Co., 30 E. 42nd St., New York City.

CARBON ELECTRODES (for Electric Furnaces and Electrolytic Work)
National Carbon Co., Inc., Electrode Sales Division, 30 East 42nd St., New York City.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CARBONS (for Arc Lamps, Blue Printing, Photographic)
National Carbon Co., Inc., Cleveland, Ohio and San Francisco, Calif.

CARBON RODS AND PASTE FOR WELDING
Oxweld Acetylene Co., 30 E. 42nd St., New York City.
National Carbon Co., Inc., Cleveland, Ohio and San Francisco, Calif.

CARBON SPECIALTIES (Circuit Breaker Contacts, Packing Rings, Filter Plates, Tubes, etc.)
National Carbon Co., Inc., Cleveland, Ohio and San Francisco, Calif.

CAR DUMPERS, GRAVITY & POWER
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Phillips Mine & Mill Supply Co., Pittsburgh, Pa.
Roberts & Schaefer Co., Chicago, Ill.

CAR DUMPERS (Rotary)
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Phillips Mine & Mill Supply Co., Pittsburgh, Pa.
Roberts & Schaefer Co., Chicago, Ill.

CAR FEEDERS
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Roberts & Schaefer Co., Chicago, Ill.

CAR HAULS
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Hockensmith Wheel & Mine Car Co., Penn, Pa.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

CARNOTITE ORES
O. Barlow Willmarth, Georgetown, Colo.

CAR PULLERS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

CAR RETARDERS
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Roberts & Schaefer Co., Chicago, Ill.

CARS OF ALL DESCRIPTION
American Car & Foundry Co., 30 Church St., New York City.
Hockensmith Wheel & Mine Car Co., Penn, Pa.

CAR STOPS, AUTOMATIC & MANUAL
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Phillips Mine & Mill Supply Co., Pittsburgh, Pa.
Roberts & Schaefer Co., Chicago, Ill.

CAR WIRE & CABLES
American Steel & Wire Co., Chicago, Ill., and New York.
John A. Roebling's Sons Co., Trenton, N. J.

CASTINGS
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Timken Roller Bearing Co., Canton, Ohio.

CASTINGS, GRAY IRON
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

CASTINGS, OPEN HEARTH STEEL
Vulcan Iron Works, Wilkes-Barre, Pa.

CASTINGS (steel, iron)
Vulcan Iron Works, Wilkes-Barre, Pa.

CAST STEEL FROGS
Central Frog & Switch Co., Cincinnati, Ohio.

CHAINS
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

CHAINS, AUTOMOBILE ENGINE
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

CHAINS, COAL CUTTING
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.

CHAINS, DRIVE
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

CHAINS, FRONT END
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

CHAIN LUBRICANTS
Standard Oil Co. (Ind.), Chicago, Ill.

CHAINS, OILING
Morse Chain Co., Ithaca, N. Y.

CHAINS, POWER TRANSMISSION
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

CHAINS, Silent (Bushed-Pin Joint)
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

CHAINS, SILENT (Rocker-Joint)
Morse Chain Co., Ithaca, N. Y.

CHAINS, SLING
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

CHAINS, SPROCKET WHEEL
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

CIRCUIT-BREAKERS
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLAMPS, GUARD RAIL
Central Frog & Switch Co., Cincinnati, Ohio.

CLAMPS (Mine)
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLAMPS (Trolley)
General Electric Co., Schenectady, N. Y.
Ohio Brass Co., Mansfield, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLAMPS, WIRE ROPE
American Steel & Wire Co., Chicago, Ill., and New York.
John A. Roebling's Sons Co., Trenton, N. J.

CLIPS, WIRE ROPE
American Steel & Wire Co., Chicago, Ill., and New York.
John A. Roebling's Sons Co., Trenton, N. J.

CLOTH, WIRE
Ludlow Saylor Wire Co., St. Louis, Mo.

CLUTCHES
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

COAL CLEANING MACHINERY
American Coal Cleaning Corpn., Welch, W. Va.
American Rheolaveur Corporation, Wilkes-Barre, Pa.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

COAL COMPANIES
Lehigh Coal & Navigation Co., Philadelphia, Pa.
Thorne, Neale & Co., Philadelphia, Pa.

COAL CONVEYING MACHINERY
American Coal Cleaning Corpn., Welch, W. Va.
Conveyor Sales Co., 299 Broadway, New York City.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

COAL CRUSHERS
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

COAL CRUSHERS & ROLLS
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

COAL CUTTERS
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.

COAL HANDLING MACHINERY
American Coal Cleaning Corpn., Welch, W. Va.
Conveyor Sales Co., 299 Broadway, New York City.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Joy Manufacturing Co., Franklin, Pa.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Mining Safety Device Co., Bowerston, Ohio.
Roberts & Schaefer Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

COAL LOADERS
Conveyor Sales Co., 299 Broadway, New York City.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Joy Manufacturing Co., Franklin, Pa.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Sullivan Machinery Co., 122 So. Mich. Ave., Chicago, Ill.

COAL MINING MACHINERY
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

COAL MINING PLANTS
American Coal Cleaning Corpn., Welch, W. Va.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Wrigley Bldg., Chicago, Ill.

COAL PREPARATION MACHINERY
American Coal Cleaning Corpn., Welch, W. Va.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Roberts & Schaefer Co., Chicago, Ill.

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Roberts & Schaefer Co., Chicago, Ill.

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Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

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Vulcan Iron Works, Wilkes-Barre, Pa.

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Robinson Ventilating Co., Zelienople, Pa.

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Pennsylvania Drilling Co., Pittsburgh, Pa.

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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Symons Bros. Co., Chicago, Ill.

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The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

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The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

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Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

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Hercules Powder Co., Wilmington, Del.

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Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.

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R. S. Patrick, Sellwood Building, Duluth, Minn.

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Keystone Churn Drill Co., Beaver Falls, Pa.

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General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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Standard Oil Co. (Ind.), Chicago, Ill.

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General Electric Co., Schenectady, N. Y.
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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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John A. Roebling's Sons Co., Trenton, N. J.

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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

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Robinson Ventilating Co., Zelienople, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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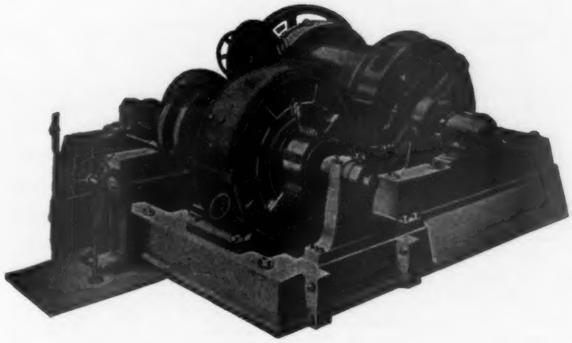

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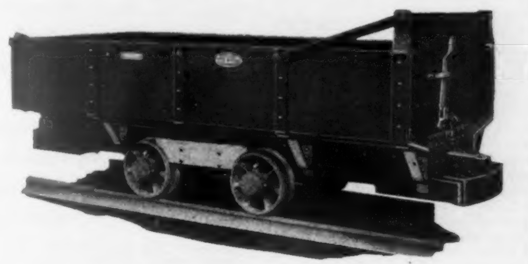

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Central Frog & Switch Co., Cincinnati, Ohio.

GAUGES, WELDING & CUTTING
Oxweld Acetylene Co., 30 E. 42d St., New York City.

GEAR COMPOUNDS
Standard Oil Co. (Ind.), Chicago, Ill.

GEARS
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The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

GEARS, BEVEL
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

GEARS (Fabroil & Textolite)
General Electric Co., Schenectady, N. Y.

GEARS, HERRINGBONE
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

GEARS, Machine Cut
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

GEARS, Moulded Tooth
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

GEARS, Silent Chain
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

GEARS, SPUR
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

GEARS, WORM
The Jeffrey Mfg. Company, 958-99 North 4th St., Columbus, Ohio.

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GLOVES, ASBESTOS
Oxweld Acetylene Co., 30 E. 42d St., New York City.

GOGGLES, WELDING
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GRATING, AREA, SIDE WALK
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GREASE
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Standard Oil Co. (Ind.), Chicago, Ill.

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John A. Roebling's Sons Co., Trenton, N. J.

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S K F Industries, 40 E. 34th St., New York City.

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S K F Industries, New York City.

HANGERS, SHAFT, DROP
S K F Industries, New York City.
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

HANGERS, SHAFT, POST
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
S K F Industries, New York City.

HANGERS, SHAFT, SELF-OILING
Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
S K F Industries, New York City.

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John A. Roebling's Sons Co., Trenton, N. J.

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Ohio Brass Co., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.

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Hercules Powder Co., Wilmington, Del.

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Vulcan Iron Works, Wilkes-Barre, Pa.

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American Steel & Wire Co., Chicago, Ill., and New York.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
John A. Roebling's Sons Co., Trenton, N. J.

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Link-Belt Co., 300 W. Pershing Rd., Chicago, Ill.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.

HOISTS, AIR
Ingersoll-Rand Co., 11 Broadway, New York City.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.

HOISTS, ELECTRIC
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.
Sullivan Machinery Co., 122 S. Mich. Ave., Chicago, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.

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Ingersoll-Rand Co., 11 Broadway, New York City.
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Vulcan Iron Works, Wilkes-Barre, Pa.

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Goodman Mfg. Co., Halsted St. and 48th Place, Chicago, Ill.

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Sullivan Machinery Co., 122 So. Mich. Ave., Chicago, Ill.

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Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
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Vulcan Iron Works, Wilkes-Barre, Pa.

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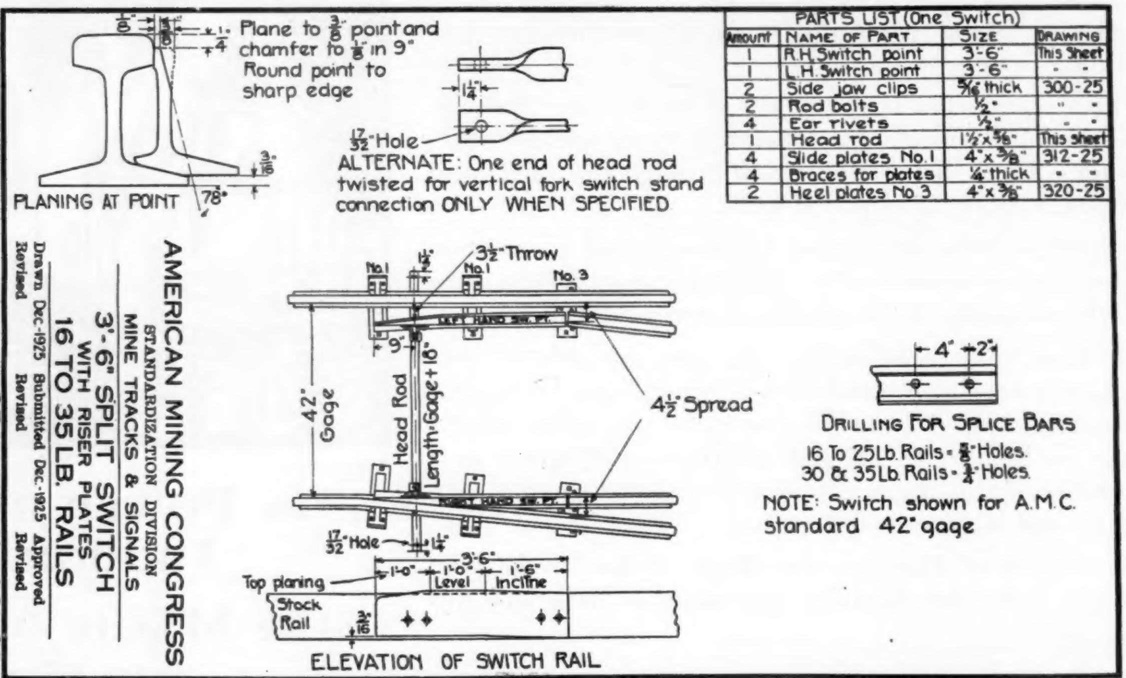

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This Handbook is pocket size, loose-leaf, and will be kept up-to-date as recommendations are approved. Two revised sections are being sent out this month—Miscellaneous Outside Coal Handling Equipment M-10-1928, A. E. S. C. Tentative American Standard, and Ladders and Stairs for Mines, M-12-1928, A. E. S. C., American Recommended Practice. The price is $5. This includes a subscription to The Mining Congress Journal. For further information, address

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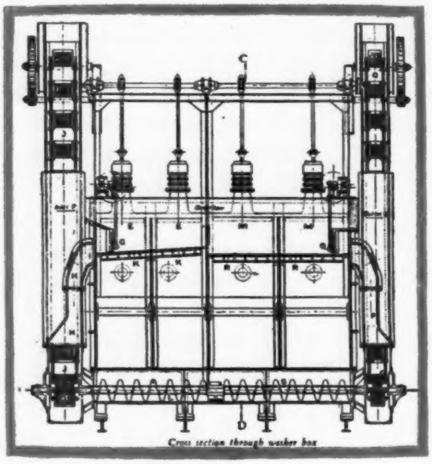
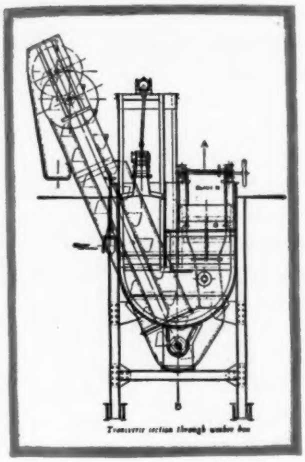
Washing all coal sizes under 5 inches —simultaneously





THE remarkable range of washing capacity is just one of a number of advantages of the Link-Belt--Simon-Carves System of coal cleaning.

It will not only wash coal from 0 to 5 inches, but do it simultaneously in one single unit, and in capacities far exceeding 100 tons per hour.

The wide range of sizes washed together makes sizing unnecessary until after washing, thus eliminating costly dry screens, dust nuisance, and the degradation of larger sizes from frequent handling.

This gives at least a suggestion of the unrivalled service which this system—new to America—offers in the present drive for better coal preparation.

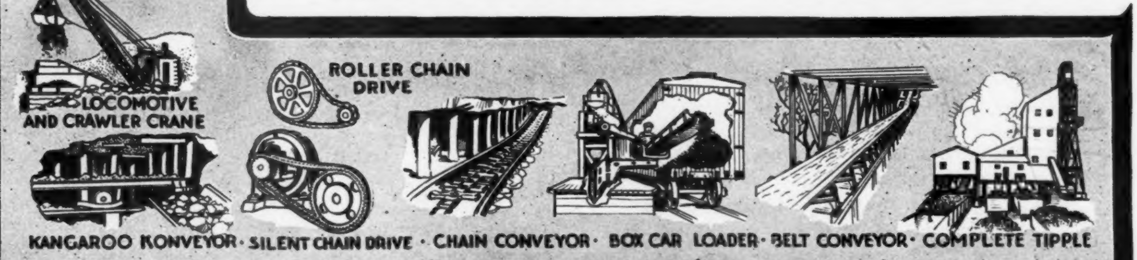
The Link-Belt--Simon-Carves System will play an increasingly prominent part in the move—now developing—to improve coal preparation in America. Engineers are urged to familiarize themselves with the details of this system.

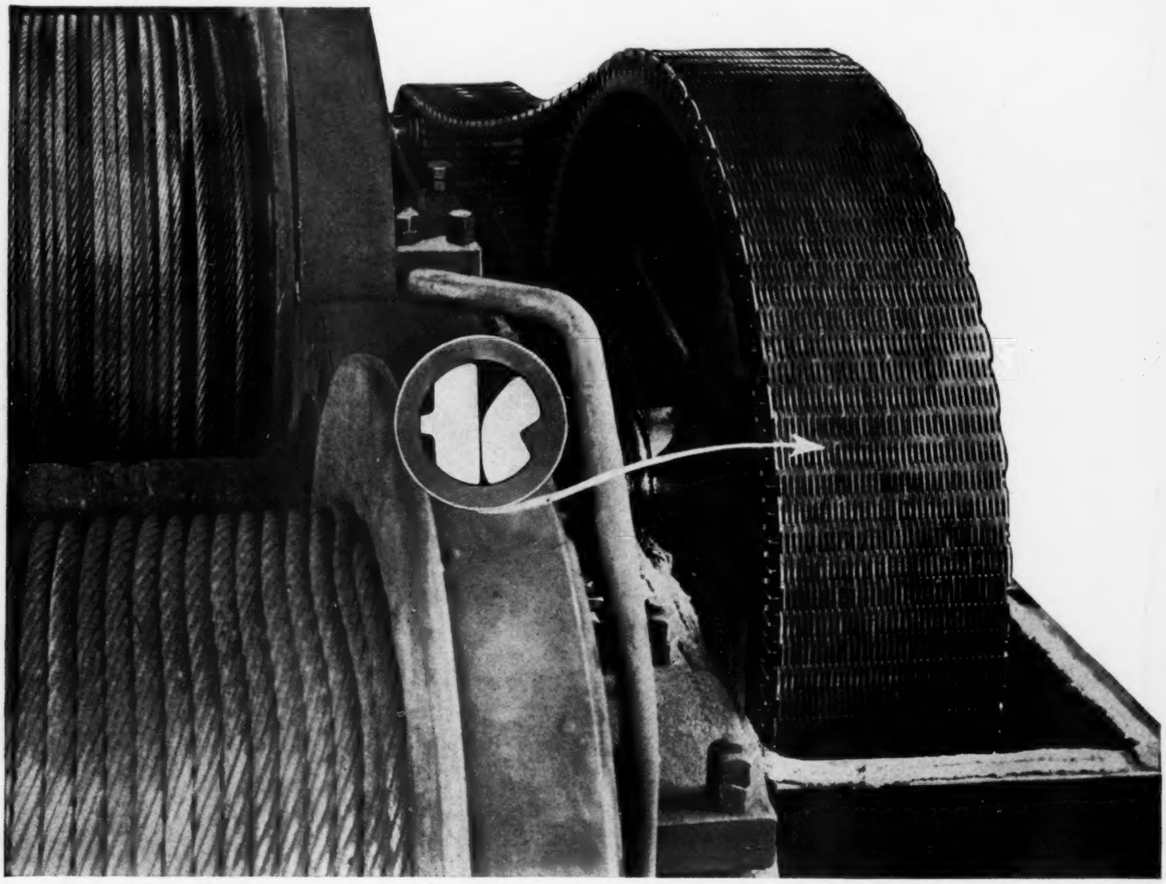
3485

LINK-BELT COMPANY
300 W. Pershing Road CHICAGO

LINK-BELT

SIMON-CARVES WASHERIES





A Man-Sized Job—

Filling in and levelling granulated slag is hard work—it requires rugged, heavy duty machinery to stand up under the strain. This Beaumont 1½ yard hoist operates the drag line scraper that is doing this work. It's driven from motor by a 75 H.P. Morse Silent Chain. That's one reason for the dependability of this equipment.

Morse Drives are extensively used on all types of machinery. They are positive, flexible, 98.6% efficient. Ideal for short centers.

Address the nearest Morse Transmission Engineer for help in your power drive problems.

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